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United States Department of Agriculture

Forest Service

NORTHEASTERN FOREST EXPERIMENT STATION

New Haven, Conn.

ANNUAL REPORT FOR 1936

April 1937

NORTHEASTERN FOREST EXPERIMENT STATION
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PERSONNEL

As of April 1, 1937

NORTHEASTERN FOREST EXPERIMENT STATION

Administration

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Mary E. Turrell	Principal Clerk
Esther S. Moos	Clerk-Stenographer
Julia J. Braun	Assistant Clerk-Stenographer
Catherine A. Heaphy	Assistant Clerk-Stenographer
Grace Moskowitz	Assistant Clerk
Lillian Mednicow	Junior Stenographer
D. F. Bissell	*Draftsman
Mary C. Weldon	Senior Clerk
Alice K. Swain	Statistical Clerk

Forest Economics

H. B. Shepard	Senior Forest Economist
C. R. Lockard	Associate Forest Economist
C. H. Stoddard, Jr.	Assistant Forest Economist
Alice Stuart	Junior Forester

Forest Genetics

E. J. Schreiner	Associate Conservationist
H. F. Marco	Junior Forester
A. G. Snow, Jr.	*Junior Plant Physiologist

Forest Management

M. Westveld	Senior Silviculturist
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L. H. Reineke	Silviculturist
I. H. Sims	Silviculturist
V. S. Jensen	Associate Silviculturist
A. P. Jacot	Associate Conservationist
H. F. Morey	Assistant Silviculturist
W. K. Starr	*Assistant Conservationist
J. H. Kraemer	*Junior Forester
K. T. Belotelkin	*Junior Forester
Frank F. Smith	*Junior Forester
Jack Zimmerman	*Junior Forester
F. E. Cunningham	*Technician - Forestry
Guy Hawkins	*Assistant to Technician

*Emergency Conservation Work or Emergency Relief Administration positions

4689

COOPERATING BUREAUS

Bureau of Entomology and Plant Quarantine

R. C. Brown	Entomologist
H. J. MacAloney	Assistant Entomologist
J. V. Schaffner, Jr.	Assistant Entomologist
P. B. Dowden	Assistant Entomologist
S. F. Potts	Assistant Entomologist
W. L. Baker	Junior Entomologist
P. A. Berry	Junior Entomologist
J. E. R. Holbrook	Senior Scientific Aide
C. T. Taglino	Senior Clerk
Henry A. Bess	*Scientific Aide
L. D. Casey	*Scientific Aide

Bureau of Biological Survey

John Pearce	Assistant Biologist

Bureau of Plant Industry

Perley Spaulding	Senior Pathologist
J. R. Hansbrough	Assistant Pathologist
T. T. Ayers	*Associate Mycologist
T. J. Grant	*Associate Pathologist
Alice J. Watson	*Technician
Harold Eno	Unskilled laborer

*Emergency Conservation Work or Emergency Relief Administration positions.

NORTHEASTERN FOREST RESEARCH COUNCIL

Appointed by the Secretary of Agriculture to serve in an advisory capacity to the Northeastern Forest Experiment Station and to coordinate and stimulate forest research by all agencies in the Northeast.

Maine	
G. T. Carlisle, Jr.	Consulting Forester
New Hampshire	
W. R. Brown	President, New Hampshire Timberland Owners Association
J. H. Foster	State Forester
J. C. Kendall	Director, New Hampshire Experiment Station and Extension Service
L. F. Whittemore	General Agent, Boston and Maine Railroad
Vermont	
P. H. Merrill	Commissioner of Forestry
Massachusetts	
H. P. Baker	President, Massachusetts State College
E. H. Thomson	President, Federal Land Bank
Connecticut	
H. S. Graves	Dean, Yale School of Forestry
A. F. Hawes	State Forester
W. L. Slate	Director, Connecticut Agricultural Experiment Station
Rhode Island	
H. R. Lewis	Agricultural Consultant

New York

J. J. Farrell	President, Farrell Lumber Company
R. S. Hosmer	Head, Department of Forestry, Cornell University
W. G. Howard	Director, Lands and Forests, Conservation Department
R. S. Kellogg	Secretary, News Print Service Bureau
G. N. Ostrander	Manager, Woodlands Department, Finch, Pruyn and Company
S. N. Spring	Dean, New York State College of Forestry, Syracuse University

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SIGNIFICANT ACCOMPLISHMENTS FOR 1936

1. The Station assumed leadership in advocating and obtaining the inclusion of farm woodland improvement practices in the new Agricultural Conservation Program and in working out technical standards for such practices.

2. The Station assumed leadership in extending the application of silvicultural control of the gypsy moth by collaboration in the publication of a bulletin on the subject and by assisting the office of Gypsy Moth Control, Bureau of Entomology and Plant Quarantine, to work out problems involved in the initiation of silvicultural measures in C.C.C. control operations in the Connecticut River valley.

3. Preparation of a report for Grafton County, New Hampshire, comparing the economic and tax status of communities where the land has been largely taken over by the National Forest with others not influenced by federal acquisition, and showing that direct contributions and indirect benefits had generally been sufficient to maintain National Forest communities in as satisfactory condition as similar areas where the tax base had remained intact.

4. The net annual growth of the residual stand in a thinning of 60-year northern hardwoods on the Bartlett Experimental Forest has been more than doubled over a four-year period as compared to the untreated stand. Growth on the thinned plot has averaged more than four-fifths of a cord per acre per year, in spite of some deterioration of yellow birch resulting from the 47 percent reduction of basal area. The rate of growth in the unthinned stand has been only 0.8 percent annually, whereas, after thinning, the growth rate increased to more than 3 percent.

5. Establishing the fact that light selective cutting in farm woodlands of central New York, removing trees of low vigor to the extent of about 10 percent of the total volume, will increase the rate of growth from about 3.2 percent to at least 3.7 percent. Cuttings of this sort will yield about 8,000 cubic feet of wood every three years on the average farm and will lead to substantial improvement in the growing stock.

6. Completed for publication by the New York State College of Forestry, under a grant from the Charles Lathrop Pack Forestry Trust, a bulletin entitled "Centralized Management and Utilization Adapted to Farm Woodlands in the Northeast", which outlines the problem of farm woodland management, illustrates the problem by analyzing conditions in the vicinity of Cooperstown, New York, and recommends as a solution a threefold plan for cooperative organization, conservative forest management, and integrated utilization through a centralized processing plant.

7. Analysis of data obtained from a set of thinning plots established in a 55-year-old spruce stand indicates that thinning old field spruce stands is a practical measure both from the yield and regeneration standpoints. Over a 29-year period the treated plot produced an average annual increment of 61.8 cubic feet per acre. During the same period an average yearly loss of 6.1 cubic feet per acre was recorded for the untreated plot. In contrast to a total absence of coniferous reproduction above 0.5 feet in height on the control plot in 1935, the thinned plot supported more than 2,800 trees per acre between 0.5 and 2.0 feet in height.

8. Collaborated with the State of Maine in planning and initiating at four Civilian Conservation Corps camps a type mapping and forest inventory project for 28 towns, comprising about 600,000 acres.

9. Analysis of 103,000 acres of burned forest land in Maine, New Hampshire, Vermont, Massachusetts, New York, and Pennsylvania shows that although the rate of burning is about 0.44 percent of the total forest area each year, it is less than 0.05 percent for almost half of the area involved. This affords ample opportunity for selective underwriting of forest fire insurance at low premium rates.

NORTHEASTERN FOREST EXPERIMENT STATION

ANNUAL REPORT FOR 1936

FOREWORD

The Northeastern Forest Experiment Station, established in 1923, is one of 12 regional stations maintained by the Forest Service, United States Department of Agriculture. The territory served by the Northeastern Station includes all of New England and New York. Headquarters are maintained at New Haven, Connecticut, in cooperation with Yale University.

The Northeastern region includes almost 40 million acres of forest, comprising considerably more than half of the total land area. A wide variety of forest types and economic conditions is represented in these forests. On the one hand there are over 11 million acres of farm woodlands or 28 percent of the total forest area, while on the other an almost unbroken wilderness of about 10 million acres still remains in northern Maine. The region includes the most densely populated industrial section of the country, and this places an unusually heavy demand on the forest for recreational as well as industrial use.

Ever since Colonial times, the forests of the Northeast have been an important source of livelihood to the people of the region, but forest fires, insect pests, diseases, and unrestricted cutting in successive waves of closer utilization fostered by proximity to the industrial markets, have so depleted the forests, especially in the more densely settled sections, that their full potentialities as a source of stable employment, industrial development, and community welfare are not being realized.

The Northeastern Forest Experiment Station was established to study the various problems involved in the management, rehabilitation, and protection of these forests in order that they may more effectively supply raw material for industry, and at the same time serve to minimize floods, protect water supplies, support a larger and more varied wildlife population, and adequately meet the recreational needs of the people.

ADVISORY COUNCIL

The experiment station is assisted in the formulation of its program by an advisory council organized by the Secretary of Agriculture. This council also serves to coordinate and stimulate forest research by all agencies in the region. Its membership includes state foresters, directors of agricultural experiment stations, heads of forest schools, educators, timberland owners, lumbermen, pulp and paper manufacturers, and other influential citizens interested in the development of the forest resources of the Northeast.

The twenty-second meeting of the council, in the fall of 1935, was devoted to detailed consideration of work in progress at the experiment station and of desirable lines of investigation in which the station is now not active. Resolutions were adopted recommending that the Northeastern

Station undertake studies of the relation of forests to water supplies, streamflow and erosion, and that work be initiated promptly on the Forest Survey in the Northeast.

The 1936 meeting was held at Williamstown, Massachusetts, affording an opportunity for the council to see the Lawrence Hopkins Memorial Experimental Forest and to meet President Tyler Dennett of Williams College. In addition to an outline by Doctor Schreiner of the lines along which effort in the new forest genetics project would be directed, and a report of progress in the cooperative management and utilization project at Cooperstown, New York, by Mr. Lockard, the forest fire research program of the Station was reviewed and discussed in some detail.

The consideration of forestry in the Agricultural Conservation Program for the Northeast was outlined by Director J. C. Kendall of New Hampshire. This is a matter in which the Northeastern Forest Experiment Station had been active during the year. At the initiation of the Agricultural Conservation Program, forestry interests were not represented, but proposals were made to make benefit payments for the planting of forest trees on lands withdrawn from agricultural use and later for fencing of woodland against grazing by livestock. Taking the position that proper management of farm woodlands constitutes a significant measure of soil building, which could not be consistently neglected in a program for the benefit of agriculture in a region where so large a proportion of the land is wooded, a group of foresters actively advocated that farm woodland improvement practices be recognized as a basis for benefit payments, and worked out recommended specifications for such practices. As a result of this activity the Agricultural Adjustment Administration announced that forest improvement practices would be accepted for the 1937 program upon recommendation of the individual state committees and several Northeastern states have made such recommendations.

Modification of gypsy moth control activities was another subject considered by the council. Mr. Hawes, of Connecticut, led the discussion by presenting his views and conclusions based on an analysis of excessive costs incurred in the Civilian Conservation Corps control project in Connecticut. He recommended that the government provide more spray outfits for the C.C.C. project and that silvicultural methods be substituted for much of the direct control by creosoting of egg clusters and banding of trees to trap larvae in summer. He also suggested abandonment of expensive "clean up" work designed to facilitate scouting for egg clusters. Finally, he recommended that the Conservation Department in Massachusetts be given direct control of gypsy moth work by the towns in that state. Discussion by the Council centered largely on the possibilities of developing forests resistant to gypsy moth attack by silvicultural means, which is a matter to which the experiment station has devoted considerable attention during the past year.

The need for aerial photographs of the entire region and of the Forest Survey was again brought out in discussion led by Director W. L. Slate of Connecticut, on land planning and development of recreational values in wild land.

COOPERATION

Bureau of Entomology and Plant Quarantine

In order to maintain closer contact with the Forest Experiment Station, the Bureau of Entomology and Plant Quarantine brought to New Haven during 1935 all the work on forest insects which was formerly carried on at Melrose Highlands, Massachusetts. This involves a staff of 8 technical men. The work includes the biological control of introduced forest insects through the importation of parasites and predators from their native habitats and the rearing and dissemination of these species throughout the Northeast, control of forest insects by use of insecticides and other methods of artificial control, and the reduction of insect populations by the use of silvicultural practices. Headquarters for the entomological work have been established at 56 Hillhouse Avenue through the courtesy of Yale University. Mr. R. C. Brown is in charge.

The Forest Experiment Station has worked actively with the Bureau of Entomology and Plant Quarantine during the past year to work out the possibilities of increasing the resistance of the forests to gypsy moth infestation through silvicultural practices. Director Behre collaborated with Mr. A. C. Cline of the Harvard Forest, and W. L. Baker of the Division of Forest Insects, in the preparation of a bulletin entitled "Silvicultural Control of the Gypsy Moth", which was published by the Massachusetts Forest and Park Association. After this bulletin came out the Station assigned a man to work in cooperation with A. F. Burgess and S. S. Crossman of the Office of Gypsy Moth Control at Greenfield, Massachusetts, in a study of the application of the recommended practices to the C.C.C. control activities in the Connecticut River valley. In this work surveys and type maps are being made of areas threatened by moth infestations and detailed recommendations for silvicultural treatment are made in each stand. The experiment station man is assisting in the training of the foreman and crews for this technical work. It is hoped that as experience is gained in the work, silvicultural measures may assume a much more important position in the entire control program, with accompanying reduction in certain phases of direct control activities, particularly in the generally infested area east of the barrier zone. Meanwhile, the surveys and records of treatment will serve as demonstrations and sample plots for evaluating the efficacy of the silvicultural measures for control.

Bureau of Plant Industry

Work of the Bureau of Plant Industry in Forest Pathology in the Northeast has also grown and now involves a force of 8 technical workers. This group occupies another University building, directly opposite the Forest Experiment Station.

At the request of the station for data to aid in records of mortality, Doctor Spaulding has prepared a set of rules for estimating the length of time trees have been dead. These are based on occurrence of various fungi which have been under observation in connection with studies of slash decay and heart rots.

Close integration of the pathological work with the station's forest management research is indicated by the setting up of studies of diseases of forest plantations as a major project this year. In recent years numerous pathological problems have appeared in forest plantations especially in those of a single species which have begun to lose vigor through crowding. Such problems will continue to demand attention because of the greatly increasing area of planted stands in the region.

Biological Survey

Work of the Bureau of Biological Survey under the McSweeney-McNary Forest Research Act was suspended during 1936 as a result of transfer of Mr. Miller to other work. Physical development of the Pillsbury State Forest in New Hampshire, in connection with wildlife studies, had been carried about as far as seemed advisable at this time and no great sacrifice is involved in the temporary interruption of observations.

In March 1937, Assistant Biologist John Pearce was assigned to the Northeastern Station to replace Mr. Miller. Mr. Pearce will make his headquarters with the experiment station at New Haven and this move should greatly strengthen contacts between the two federal agencies. It is anticipated that cooperation with the State of New Hampshire in studies of wildlife and forest management at the Pillsbury State Forest will be continued.

Washington Office

During the year 1936 the station was called upon to prepare a report on Grafton County, New Hampshire, as part of the nation-wide study of National Forest contributions to local government. For this report economic conditions were studied in 15 National Forest towns and 2 towns in a comparable area unaffected by federal acquisition. In New Hampshire the state abates to National Forest towns an amount not exceeding half of the taxes which might have been received had National Forest lands been taxable. This, together with the return of 25 percent of National Forest receipts, has largely offset loss of local revenues even though the 25 percent fund has been erratic and for the 15 towns studied dropped to a low of $529 in 1933 from a high of $8,934 in 1930. The average annual tax loss in these towns has been only $1.28 per capita. On the whole, National Forest towns are in better shape and exhibit a higher standard of living than comparable towns not affected by federal acquisition.

During April and May the station director was called to Washington for an administrative detail of about six weeks in the Branch of Research, and during the fall he was again in Washington for several weeks for a detail in the Chief's office.

Region 7, United States Forest Service

Cooperative relations with the White and Green Mountain National Forests and with the Regional Office have been numerous and satisfactory during the past year. The station has drawn continuously upon the C.C.C.

camps for assistance in its research and development programs on both the Gale River and Bartlett Experimental Forests, and the camps adjacent to these forests have continued to obtain a major part of their fuelwood supply from cuttings on the experimental forests. The National Forest organization assumed responsibility for the boundary survey of the Massabesic Experimental Forest being acquired from the Bates College estate at Alfred, Maine.

The experiment station has undertaken a study of growth as a contribution to a survey of forest resources which the region is making in connection with the Forest Products Cooperative Association in Coos County, New Hampshire, and Essex County, Vermont. Similar cooperative arrangements are also being worked out in connection with another cooperative sustained yield project in Tioga County, New York.

At the request of the White Mountain National Forest, the station has undertaken a study of visibility and lookout placement in connection with a comprehensive analysis of fire control planning for that forest. Similarly, at the request of the Division of Clarke-McNary Cooperation, the station has offered technical assistance to the State of Rhode Island for lookout visibility studies which are to be done by the C.C.C. Records of fire experience compiled in the forest insurance project were made available to the Division of Clarke-McNary inspection in connection with its analysis of fire control planning in Vermont.

In the spring of 1936 the station had its first joint program conference with the administrative group. As a result of this a two-day field trip to see the planting experiments under way at the Chenango Experimental Forest and to become familiar with the New York State reforestation program was arranged by the station in October for representatives of the Regional Office and of the three Northeastern National Forests. Following this, representatives of the station made a trip to the Green Mountain National Forest to discuss silvicultural problems with the forest management staff in the field. This trip was followed up later in the fall when Mr. Jensen assisted in marking of selective cuttings for the season's fuelwood operations on the Green Mountain Forest. This cooperation will be enlarged next year when it is planned to establish some permanent sample plots in Vermont for study of selective cutting.

Representatives of the station have been asked to participate in a number of the monthly staff conferences on the White Mountain National Forest, and these have proved very helpful all around. During November the White Mountain staff met at the Bartlett Experimental Forest to become familiar with the experiments in selective cutting under way there. This work provides substantial background for the adoption of a light selective cutting policy in the camp fuelwood operations and elsewhere to the extent that local conditions warrant. At the time of this meeting the Forest staff also visited the Cherry Mountain experimental areas where the results of cuttings and plot records dating back to 1924 could be studied.

State E.C.W.

At the Finch Pruyn Experimental Forest in New York, construction of truck trails and bridges has been undertaken by the C.C.C. camp on the Huntington Tract of the New York State College of Forestry. Cooperation from the New York State Conservation Department has likewise been extended for assistance in experimental plantings and for other miscellaneous work on the Chenango Experimental Forest from a state C.C.C. camp.

In Maine, the state C.C.C. camp at Alfred is constructing truck trails and providing crews for timber stand improvement work and forest inventory on the new Massabesic Experimental Forest. On the other hand, the station has provided technical direction in planning and initiating a forest type map and timber survey project at four camps in southwestern Maine.

Other Agencies

The New York State College of Forestry has been greatly interested in our efforts to establish a basis for cooperative forest management and utilization at Cooperstown, New York, and has cooperated actively in an educational program in the territory to be served by this project. A bulletin on this project by Behre and Lockard is being published by a joint grant of funds from the New York State College of Forestry and the Charles Lathrop Pack Forestry Foundation.

During the past year the station has cooperated with the Connecticut Forest and Park Association in its efforts to stimulate the use of wood for fuel. This Association has arranged for the importation of new type slow combustion stoves from Europe which have an operating efficiency about double that of ordinary wood burning stoves. It has published a pamphlet entitled "How to Burn Wood", describing these stoves and discussing other aspects of the fuelwood problem. The Association has tried to make arrangements for testing the use of hogged wood as fuel in industrial boilers. Although considerable interest has been developed and preliminary tests were made with coal in a plant where installation of wood burning equipment was contemplated, little actual progress has been made. The most promising lead appears to be in cooperating with the brass industry to explore the possibilities of using wood-gas furnaces for processing certain of its products where freedom from sulphur in the fuel is essential. Through the Connecticut Forest Service the Association is also sponsoring tests on the use of crates for handling cordwood in unit packages to reduce transportation costs.

Helpful cooperation from all the state foresters in the region has been extended in making their forest fire records available to the station and otherwise assisting in the study of forest fire insurance. Active cooperation from numerous persons throughout the region continues in the collection of phenological and seed crop data.

EXPERIMENTAL FORESTS

In developing an adequate program of research in the region, the Northeastern Forest Experiment Station aims to concentrate its work to a large extent on experimental forests, set aside especially for the purpose. Experience has shown that this is a wise policy not only because it safeguards long-time experiments from outside interference, but also because it permits accumulation of more detailed information concerning the meteorological and ecological conditions under which the experiments are conducted. It also leads to greater efficiency in handling the work, and better correlation of different lines of investigation in the same locality.

Material progress has been made in rounding out a system of experimental forests which should eventually represent all parts of the station territory. The two areas described below bring the total number to six.

The Lawrence Hopkins Memorial Experimental Forest

On November 27, 1935, the Secretary of Agriculture accepted a gift of 1,635 acres of land from the trustees of Williams College at the outskirts of Williamstown, Massachusetts, for the purpose of establishing and maintaining an experimental forest to be known as the Lawrence Hopkins Memorial Experimental Forest. The topography on the eastern end of the tract is rolling but rises steeply at the western side to the summit of the Taconic range. Elevations range from 800 feet to above 2,000 feet, with most of the tract below the 1,400 foot level.

The chief objective in considering an experimental forest in central New England was to have an area representative of large portions of the region which had formerly been developed for agriculture. Conservation of wildlife, recreation, and protection of water supplies will be important aspects of forest land use in the region of which this tract is typical. Maintaining desirable conditions for game and wild life will be a corollary objective in our plans for the development of the tract for forestry. Abandoned farm lands in this region are more than a forest planting problem, since a large proportion of such lands have already grown up to a forest growth of some sort. The old field growth is often of poor form, low density, and inferior species. How such lands in the Northeast may be restored to a productive condition is a problem of fundamental public interest toward the solution of which work on the Hopkins Memorial Experimental Forest should make substantial contribution. This tract also lends itself well to a study of the influence of forest cover and its management upon streamflow.

Two of the buildings on the forest are being repaired and remodeled for use as dwelling and office quarters. A topographic survey has been completed and a permanent system of cruise plots established.

The tract donated by Williams College should be rounded out by acquisition of one interior lot and a few adjacent properties. It is possible

that purchase of these back farms may be handled by the Resettlement Administration.

Massabesic Experimental Forest

The National Forest Reservation Commission at its meeting of January 30, 1936, approved the purchase of a portion of the former Bates College Forest near Alfred, Maine, to be used as an experimental forest. The tract, comprising approximately 2,500 acres, lies in the heart of the white pine region of southwestern Maine and is admirably adapted for studies related to the management of white pine types. The forest has been under management for 13 years. During this period, cuttings have been made on a selection basis and pine growth has been liberated by removal of large quantities of hardwood fuel. Complete inventories have been made at 5-year intervals so that a good picture of forest conditions for more than 10 years is now available. Records also have been kept of the amounts of timber and wood which have been taken out from each lot. An attractive administrative site on the state highway about 2 miles east of Alfred has been approved for purchase. It includes a colonial farmhouse which will be remodeled for office space and resident officer's dwelling.

The Massabesic Forest should be rounded out by purchase of a number of adjacent properties. The boundaries at present are extremely irregular and intensive development will be hampered by question of rights-of-way, limited area in certain stands, etc. Much of the intermingled land has been offered for sale by the present owners. A bill consenting to additional purchase was enacted by the Maine legislature in February 1937. The area might well be increased by about 3,000 acres.

The physical development of the various experimental forests has been furthered by the availability of emergency funds. Office, laboratory, and housing facilities have been improved; roads have been extended to facilitate harvesting the timber resources; trails, fire lanes, and water holes have been constructed to aid in the administration of the units and to protect the investment in experimental work under way.

The status of the development of the experimental forests is indicated in the following table.

Status of Experimental Forests
January 1, 1937

Location		Name	Date Established	Area, acres	Number of Buildings					Mileage of Roads			Predominant Purpose
State	Town				Dwellings	Office Bldgs.	Garages	Others	Total	State and County	Forest Roads	Total	
Me.	Alfred	Massabesic	1936	2,485						20.0	1.7 3/	21.7	Management of white pine
N. H.	Bartlett	Bartlett	1932	2,600	2	1	3	4	10		17.3	17.3	Management of northern hardwoods
	Bethlehem	Gale River	1931	1,320	1	1	2	5	9	4.5	5.1	9.6	Management of spruce
Mass.	Williamstown	Hopkins Memorial	1935	1,635	2	1	1/	1	4 2/	2.0	-	2.0	Rehabilitation of abandoned lands
N. Y.	Smyrna	Chenango	1933	635	1		1	2	4	2.7	-	2.7	Forestation studies
	Newcomb	Finch-Pruyn	1934	623	1		1	2	4	1.5	0.5	2.0	Management of spruce & northern hardwoods

1/ Space available in office building.
2/ Not including mansion and numerous farm buildings not needed for immediate use.
3/ Under construction.

The truck trail system on the Gale River Experimental Forest was completed in 1934; that on the Bartlett Forest should be completed in 1937. Plans for the other forests include additional truck trail construction approximately in the following amounts: Massabesic Forest, 7 miles; Hopkins Memorial Forest, 4 miles; Chenango Forest, 3 miles; Finch Pruyn Forest, 2 miles.

No new buildings are contemplated at the Bartlett Forest. A year-long superintendent's residence is needed to complete construction work at Gale River. Remodeling of old buildings on the Hopkins Memorial Forest should meet all needs for some time to come, except that additional storage for motor trucks may be required if a C.C.C. side camp is established there. In addition to remodeling of the farmhouse and extension of the power line to the administrative site on the Massabesic Forest, a garage and an additional staff dwelling will be needed. The Chenango Experimental Forest should have a separate structure for office and laboratory.

In addition to its six experimental forests, the Station has a substantial volume of work at three other centers. Two of these on the White Mountain National Forest are handled in connection with the Gale River Experimental Forest. The first is at Cherry Mountain, New Hampshire, where investigations of methods of cutting, thinning, girdling, weeding, and slash disposal in spruce types are under way. The second is at Waterville, New Hampshire, and the experiments there are along lines similar to those at Cherry Mountain. The third center of work is at Cooperstown, New York, which is serving as a center for economic studies dealing with cooperative management and utilization of farm woodlands. The Station maintains rented office quarters for this work at Cooperstown.

Plans for the future should include consideration of additional experimental forests in portions of the region not now adequately represented. To round out studies in the spruce region, it will be desirable to select an experimental area in the Grand Lake Purchase unit in eastern Maine, when acquisition has been effected there. The Northeastern Station should also have an experimental area in the oak region of southern New England. The Connecticut State Forester has offered to work out cooperative arrangements for use of a portion of one of his State Forests for this purpose.

NATURAL AREAS

Only one natural area has been set aside in the Northeast. This is known as the "Bowl" and comprises one side of a natural basin on the slope of Mount Whiteface, not far from Tamworth, New Hampshire. This area of about 510 acres was approved in 1931. It contains representative virgin stands ranging from northern hardwoods in the valley bottom through a narrow zone of spruce hardwoods to some fine pure spruce slopes. At the higher elevations this area reaches close to timber line.

Other portions of the White Mountain Forest containing more or less extensive stands of virgin spruce on upper slopes, although not suitable for designation as Natural Areas, are included in the protection zone and will not be disturbed by commercial exploitation.

The Regional Forester has planned an exploration of the newly acquired portions of the White and Green Mountain Forests to determine whether there are other tracts which should now be set aside as Natural Areas. Experiment Station men will join with the Region in final decision on any new proposals.

STATUS OF INVESTIGATIONS

FOREST ECONOMICS

Forest Fire Insurance

Work on the studies of forest fire insurance in the Northeast will be completed in 1937. In this project attention has been given to the extent and character of forest fire losses, the study of factors affecting variation in fire hazard, and study of influences on administrative and underwriting requirements. Field work included the states of Maine, New Hampshire, Vermont, Massachusetts, New York, and Pennsylvania. Fire records for a 10-year period were analyzed and over 103,000 acres of burned area were surveyed in the field. The compilation of forest fire experience from state records has been used by the Region 7 Division of Clarke-McNary Law Inspection, and the data on burned areas provide a substantial background for current evaluation of fire damage.

The study shows that there is ample opportunity for entirely practical forest fire insurance in this region. Although forest area of the six states, taken as a whole, is being burned at a rate of 0.44 percent per year, for almost half of the forest area involved, the rate of burning is less than 0.05 percent per year. It is thus obvious that a wide opportunity is afforded for selective underwriting and a low premium rate level.

Forest fire insurance can be a real help in promoting better forestry practices on private lands in the region. Not only will it aid directly by increasing the safety of the invested values, but it will also influence improvements in protection, chiefly because of the owners' desires for lower premium rates. The tendency will be to strengthen weak points, while maintaining standards already established elsewhere.

Cooperative Management and Utilization for Farm Woodlands

An appropriation was made in 1935 for studies to establish a basis for cooperative management and utilization of farm woodlands in the vicinity of Cooperstown, New York. The work has been directed along three main lines.

1. A study of the forest resources on individual properties to determine the kind and quality of timber available, its rate of growth, and possible application of a suitable system of forest management.

2. Development of a cooperative organization as a basis for sustained yield management and centralized marketing.

3. Study of available markets for forest products from the locality and of the character of manufacturing facilities required to prepare local timber most efficiently for diversified outlets.

When operations get under way, the work will be expanded to include analysis of methods and costs in all stages from stump to car. Special attention is to be given to increased efficiency in the production and distribution of fuelwood. The forest resources have been inventoried on 120 farms with an aggregate area of merchantable timber of about 4,000 acres. These woodlands average about 71 square feet of basal area per acre. Of this amount, 40 percent is in trees less than 12 inches in diameter, and only 13 percent is in trees more than 20 inches in diameter. The marking policy followed in these stands aims to remove only 10 percent of the stand, taking trees of low vigor and poor quality in all size classes. A study of growth indicates that successive cuttings of similar intensity may be made at intervals of three to five years. On this basis, about 250 farms will have to be worked over each year to yield a sawlog output of between 2,000,000 and 3,000,000 board feet.

The Otsego Forest Products Cooperative Association, which was organized in 1935, now has a membership of 232 farmers with a forest area of over 10,000 acres. The application of the Association for a loan of $100,000 has been received favorably by the Resettlement Administration, and it is anticipated that final approval of the loan will be forthcoming early in 1937.

The present unsatisfactory situation with regard to farm woodland is attributed in large measure to the lack of adequate facilities for processing the material to meet competition from other regions and to the inability of the individual farmer to market his timber in a way which will realize its intrinsic value. It is believed that the problem can be met through cooperative organization which will permit a group of farmers working together to accumulate a sufficient volume of material to justify sorting and grading to effectively supply the market for diversified products, but it is felt that the advantages of cooperative organization cannot be fully realized unless the producers control their own processing facilities. Only in this way can the manufacturing processes be oriented from the point of view of serving the producer and promoting the objectives of sustained yield. To obtain income from his woodlands under existing conditions, the owner is forced either to sell to small portable mills which rarely are in condition to pay full value for the timber and generally convert the entire stand into a single product with little effort to utilize the waste, or to the specialized consuming industries which afford him an outlet for only the higher grade material, which constitutes only a small proportion of what he has to sell. For these reasons, the Otsego Forest Products Cooperative Association is being advised to erect an efficient processing plant, with the recommendation that manufacturing be limited as far as possible to the primary processes necessary to convert each class of material into the form in which it can be marketed to best advantage. In this way, the whole program of cooperative forest management and utilization will constitute an improved channel between the producer and the consuming industries, and should provide the solution to an important economic problem in the region.

Costs of Production

An important aspect of forest management in the Northeast is revealed through analyses of cost of producing lumber and other products from trees of different sizes and through study of the effect of selective or partial cuttings upon operating costs. As a general principle, conservation of the forests will be promoted by selective or partial cutting rather than indiscriminate clearcutting.

In the fall of 1934, production cost studies were conducted on six northern white pine lumber operations in New England in cooperation with the Forest Products Laboratory. Results of this work were made available in preliminary form during 1935. The cost of producing a thousand feet of lumber from trees only 5 or 6 inches in diameter is about twice as great as from trees 16 to 18 inches in diameter. Because of the knotty character of most of the northeastern second growth pine, the quality of the product was not significantly affected by size of the trees.

Although trees as small as 6 inches in diameter may be said to "pay their way", an adequate margin for interest, taxes, and stumpage is only obtained in handling trees over 10 inches in diameter. The advantage of minimum costs for trees 15 inches or more in diameter will be accentuated in the future as better quality is realized as a result of pruning and improved forest management in young stands.

Because the proportion of trees in the smaller size classes will generally be higher in clearcutting than in selective cutting, the latter practice will yield a larger net profit per thousand board feet than the former. These results should not only stimulate partial cutting but should tend to conserve immature stands from liquidation and encourage the building up of larger growing stocks.

Another important phase of this project will be continued observations and remeasurements of the several areas on which studies were undertaken. Only in this way will it be possible to obtain a fair comparison of ultimate development of the forest under different cutting methods.

During 1935 similar analyses were made in cooperation with the Forest Products Laboratory on three northern hardwood lumber operations. A preliminary report on one of these indicated that the increased price per thousand board feet for maple squares for shoe heels did not offset the additional cost and the waste involved in converting plank into the heel stock. Marketing hardwood in the form of lumber would appear to be more profitable.

Preliminary indications based on the studies of farm pulpwood operations in second growth spruce and fir stands in Coos County, New Hampshire, indicate that here, as well as in pine stands, the operators are cutting trees that might better be reserved. For several reasons

the spread between sale value and production costs of pulpwood is less pronounced than indicated on the pine and hardwood studies. Pulpwood, sold by the cord, does not involve a disproportionately large amount of waste in the smaller size classes; this was one of the important factors in the pine and hardwood lumber studies where slabs and edgings made up a large part of the volume. The operator has less incentive for producing quality material for pulpwood than lumber, as he neither receives a premium for a high proportion of large clear pulp sticks nor is he ordinarily penalized for an inferior (small, knotty) grade of sound wood. Pulpwood owners ordinarily contract the various operations and feel that cutting small trees is the contractor's loss rather than the owner's. The contractors are reluctant to reduce the price per cord if they are not required to utilize the small trees as they feel the gains would be largely offset by additional operating difficulties in making partial cuttings. The customary windrow method of cutting facilitates skidding and yarding operations, although this advantage is at least partially offset by the increased size of the average tree utilized in a selective system of cutting. Partial cuttings in this locality have ordinarily been too heavy for satisfactory silvicultural result. However, the relatively light experimental cuttings favoring trees that appear windfirm give more promise of satisfactory development. Some landowners justify their heavy cutting operations as the first step in converting the land to needed pasture, although the cutover areas are wholly unsuited for this purpose. Probably the greatest deterrent to partial cutting operations is the immediate need or desire for the highest possible cash returns from the land. Some owners admit they are cutting trees just when they are beginning to put on the greatest merchantable growth but indicate they would rather meet an urgent present need for cash than reserve a portion of the stand as an investment.

There is need to extend production cost studies to cover a wider range of operating conditions, other forest types, and other forms of utilization. Such studies will provide a sound basis for forest management and utilization policies for both public and private agencies. They also yield data needed for the analysis of defect in standing timber and for the preparation of log grading rules to facilitate timber marketing.

FOREST MANAGEMENT

Forest Planting

The impetus given in recent years to reforestation of abandoned farm lands in the Northeast has focused attention to the need of undertaking intensive research in the field of forest planting. As an initial step in this direction, the Station in 1931 inaugurated an extensive survey of plantations throughout the region. The survey, which involved measurement of some 450 plots, representing a wide variation in age, mixture, and site, aided materially in crystallizing a definite program of planting investigations.

The present program now embraces the following lines of study:

1. Methods of planting aimed at increasing success and reducing the cost of forest planting.

2. Problems relating to the establishment of mixed plantations.

3. Methods of reforestation for areas of poor drainage and heavy competition.

4. Elimination of competition from weed tree growth by poisoning.

5. Questions relating to source of seed.

6. Fertilizer response in young plantations.

Following the extensive survey of plantations, major emphasis was directed toward the accomplishment of the first objective, study of the effect of method and depth of planting on survival and development. In 1932 several planting jobs were studied and staked rows were set out to follow survival, growth, and vigor of the trees for several years. In 1933 and 1934 controlled experiments involving different methods and depths of planting were initiated. In 1935 this phase of the study was still further expanded to include planting in ploughed furrows. The experiments show trees planted in dug holes are distinctly superior to those set in slits without cultivation; also, trees set very low result in lower survival than trees set high or slightly low. Red pine appears less sensitive to low setting than white pine, white spruce, and Norway spruce. Extremely low planting results in root decay and often the ultimate death of the tree. Recent studies indicate that should the tree survive the early sloughing off of the rootlets, it may eventually put out new roots and continue growth, but at a slower rate than trees planted more nearly at optimum depth.

Experiments relating to mixed plantations are being concentrated on the Chenango Experimental Forest. Three different schemes for establishlishing mixtures of hardwoods and conifers are being tried. One of these

provides a skeleton planting of widely spaced white pine (12' x 12') on a 49-acre area to be later interplanted with desirable hardwoods after the pine has begun to grow vigorously. The pine was set out in 1933. Interplanting of hardwoods was initiated in 1935, using direct seeding as well as nursery stock.

Another scheme involves planting approximately 26 acres of alternate strips, of hardwoods and white pine, some 5 and some 10 rows wide. Only half the length of each hardwood strip was planted at the same time as the white pine; the balance of the hardwood strips is to be planted when the white pine has reached a height of 2 to 4 feet. The hardwoods used in 1934 were black locust, red oak, and white ash. It is planned to extend the strip planting to include sugar maple, basswood, and black cherry.

The third scheme calls for the establishment of group plantings of white pine and hardwoods on a 25-acre tract. Groups of 6, 9, and 13 trees, spaced 3 to 4 feet apart, were arranged with centers of the groups 13, 15, and 17 feet apart, making 258, 193, and 151 groups, respectively, per acre. In all of these experiments the possibility of obtaining proper competition and desirable canopy conditions by delaying the planting of hardwoods until a few years after planting of the pines is being recognized.

Reforestation of wet lands which revealed itself as a significant problem in the course of the extensive plantation survey is now receiving detailed study on the Chenango Experimental Forest. Here experiments have been started in surface drainage, as well as detailed ecological studies of certain wet portions of the forest where survival of planted stock has been low. The wet areas, often extremely productive, present a difficult planting problem. The well drained, wet soils support dense, competing vegetation resulting in low survival of planted stock, while on the poorly drained soils excess moisture impedes successful planting. Test plantings have been made of small amounts of yellow birch, white cedar, swamp white oak, and white ash. Further plantings of other moisture tolerant species will be made in connection with this work. Through the examination of soil profiles and analysis of the vegetation on sample quadrats, it is hoped a direct correlation between the abundance of certain plants and soil conditions may be established which will be of value in classifying land on the basis of species best adapted to them.

Experiments in ridding abandoned farm lands of wild apple, hawthorn, cherry, and popple by poisoning in preparation for planting were further supplemented in 1935 with detailed studies of the relation of season of year and strength of solution upon mortality and prevention of subsequent root suckering and sprouting. Observations to date indicate that sodium arsenite is more effective as a tree killer than Atlacide; that a concentration of $2\frac{1}{2}$ pounds of sodium arsenite per gallon of water administered during the summer period is extremely effective in killing the stem and crowns of trees. Final conclusions must await observations over at least two growing seasons.

Certain questions relating to source of seed are also receiving attention. Efforts are being directed to the adoption by nurseries of an improved form providing for a continuous record of nursery stock from seed to plantation. State forestry departments are giving the forms a trial. Experimental plantings of stock of promising strains have been made in different parts of the region. Eight such field plantings have been made of a straight-boled, rapid growing Scotch pine from stock of known origin. A series of plantings of Balkan white pine (P. peuce), presumably resistant to blister rust, are also under observation. On the Chenango Experimental Forest, development of stock grown from seed gathered locally is being compared with that of stock grown from seed obtained in different climatic zones.

Although preliminary plans were prepared for studies of fertilizer response in young plantations, no opportunity was provided during the past year to get any work under way along this line.

Management of Spruce Types

Regeneration. During the early stages of spruce management studies, the principal concern was the development of a silviculture which would successfully regenerate spruce stands. Spruce stands may be classified into two broad groups (1) those of most common occurrence which can be easily regenerated through relatively simple and inexpensive measures; (2) those less abundant as to area, consisting of (a) dense, even-aged stands of immature spruce and fir, (b) stands with strong admixtures of northern hardwoods, in both of which regeneration of spruce presents a difficult problem.

Past and present cutting methods have introduced numerous complicating factors into the problem. Rapid rise in the price of pulpwood during the first 20 years of the present century resulted in practically clearcutting spruce and fir, leaving the associated hardwoods to dominate the stand. These trees spread great quantities of seed over the newly cutover areas, producing myriads of hardwood stems. Such a scheme of cutting places the incoming stand of spruce and fir under the severest of handicaps. How to maintain or increase the proportion of spruce in the mixed spruce and hardwood forests of New England and New York became at once the all important problem. Considerable progress has been made toward its solution.

Studies conducted over a period of years throughout the north woods have established certain broad working principles as a basis for successful spruce management. For the first group of stands, those easily regenerated, a fairly detailed technique for successful regeneration has been developed. These stands usually have an abundance of advance reproduction to work with. Successful management lies mainly in protecting the young growth from logging damage, from subsequent wind throw and fire, and from excessive shading and crowding by hardwoods. The technique for accomplishing this is fully covered in bulletins and articles published in various journals.

The problem of how to regenerate spruce stands falling in the second category, those difficult to regenerate, is much less simple. In such stands softwood reproduction is generally absent or deficient. Studies indicate that the dense, even-aged spruce and fir stands should be given a light initial cut, removing one-fourth to one-half the stand, permitting the establishment of reproduction under the shelter of the remaining trees. Ten to fifteen years later, when reproduction is fully established, the remainder of the old stand may be cut.

When adequate reproduction of softwoods is not present in stands containing strong admixtures of northern hardwoods, no method of cutting now practicable will, with any certainty, prevent an increased representation of hardwoods in the succeeding stand. Stands in which sugar maple and beech predominate are particularly liable to be unsatisfactorily stocked with spruce and fir reproduction. Much remains to be learned about soil, light, moisture, and competition factors affecting the establishment of spruce and fir reproduction under various stand conditions.

Cultural Treatment. Recently efforts have also been directed to the accomplishment of two additional objectives: (1) increasing the growth rate of spruce; (2) improving its quality. Of the measures developed for accomplishing the first of these objectives, the most economical and effective so far devised is girdling defective hardwoods to favor the spruce component of the stand. Experiments indicate that girdled lands can be made to produce pulpwood several times as rapidly as similar ungirdled areas. The striking results obtained from experiments in girdling have given impetus to its general adoption as a stand improvement measure in the region. Attention is now being given to the effects of partial as against full girdling, to the relative value of girdling in young stands and in stands of merchantable size, and to the relation of girdling in various spruce types to subsequent cultural operations.

As a part of the general objective to increase the growth rate of spruce, an experiment in drainage of a 200-acre swamp has been initiated on the Gale River Experimental Forest. The experiment is of too recent origin to show effect on growth rate, but the drainage ditches constructed in 1934 have lowered the water table level approximately six inches during the period May 1 to December 1, 1935. The effect of drainage on soil temperatures and ground flora, as well as possible changes in the morphological appearance of black spruce which may result from changes in its physiological environment, are being followed up as far as available funds permit.

Progress can also be recorded in the development of measures for improving the quality of spruce stands. Experiments in weeding, poisoning, and girdling as a means of eliminating undesirable tree species in the stand, have been initiated in the past several years. Weeding has proven to be an effective measure for preventing replacement of valuable spruce by the more rapidly growing worthless hardwoods. A technique for the application of weeding operations to various stand conditions in the

spruce region is now being worked out. Experiments in poisoning and girdling undesirable trees have met with varying degrees of success. Used in strong enough solution, sodium arsenite effectively kills the stems of trees, but fails to kill their root systems, permitting the latter to send up root suckers or basal sprouts. On the other hand, girdling has been found to be superior to poisoning in preventing root suckering of aspen.

Sawtimber Production. A group of compartments on the Gale River Forest are serving as demonstrations of practices which, in the light of present knowledge and experience, should result in maximum sustained yield of high quality spruce sawtimber. The stands in these compartments vary considerably in density, age, composition, and in reproduction and site conditions. A considerable portion of the area supports a fairly dense, practically even-aged stand of spruce and fir about 60 years of age through which overtopping hardwoods occur as scattered individuals or groups. In other portions the spruce and fir is essentially an understory ranging from seedling to pole size with hardwood canopy, chiefly of paper birch, practically continuous. The objectives of management on this unit tie in with the thesis that maximum sustained yield can best be obtained by growing timber to large size and going over the ground with selective cuttings in cycles of not more than 20 to 30 years. The project eventually will contribute valuable knowledge on all phases of spruce silviculture. The steps so far undertaken are:

1. Pruning of the most promising sawlog crop trees in the 4- to 8-inch diameter groups in 1933 and 1934. An average of 62 trees per acre was pruned on an area of approximately 80 acres.

2. Cutting of hardwoods and girdling of those considered unmerchantable to release spruce and fir from overhead competition and increase the proportion of softwoods. Over 600 cords were cut in 1935 on approximately 40 acres, an average of 15 cords per acre.

Future operations planned for the unit consist of:

1. Completion of hardwood cutting and girdling operations on balance of 80-acre unit.

2. Removal of balsam fir of merchantable size, together with defective or poorly formed spruce, in the period 1937 to 1940. This cutting will function as thinning, will still further increase the proportion of spruce, and will forestall losses of balsam fir from rot and windfall.

3. Light cuttings of spruce and fir pulpwood and unpruned sawtimber spruce in 1930 and at intervals of 10 years thereafter, removing trees which have fallen well below the average in growth rate and maintaining optimum conditions for continued growth of sawtimber crop trees.

4. Light selection cutting of large-sized sawtimber crop trees beginning about 1975 carried on thereafter in conjunction with pulpwood cuttings, thus integrating spruce sawlog production with pulpwood production.

On portions of the unit where reproduction and site conditions favor hardwood development, weeding operations will be necessary to prevent elimination of softwoods. The frequency and intensity of the weeding will be determined by examination of conditions on the ground. Selection and pruning of future sawtimber crop trees will be done currently as they enter the 3- to 5-inch diameter class.

Growth on Cutover Lands. In planning sustained yield management for forest units, it is essential to have a sound criterion for estimating future production on cutover spruce lands. Such a criterion in the form of an equation has been developed for the spruce flat and spruce hardwood types. Volume of spruce and fir on cutover lands is expressed as a function of time, density, or the relationship between number of trees and their average diameter, and the proportion of total basal area represented by spruce and fir. It is hoped that these studies can be extended to spruce and fir burns which occupy extensive areas in the Northeast.

Owing to the urgent need for information regarding conditions obtaining on old field spruce lands following cutting, a study was undertaken in 1936 involving the measurement of 112 plots varying widely as to age of cutting, composition, and reproduction conditions. This work should establish sound principles for successful management of old field spruce stands, which are being so rapidly stripped for pulpwood by the farmers of the region.

Management of Northern Hardwoods

Clearcutting versus Selective Cutting. One of the major problems in the management of northern hardwoods centers around the extent to which selective or partial cutting may be substituted for the clearcutting now in general practice.

Partial cuttings in the past have frequently been followed by serious decadence of the residual stand, especially marked in the case of yellow and paper birch. Primarily to determine what factors were responsible for this decadence, a pair of thinning plots were established in 1932 in an even-aged northern hardwood stand of pole size containing a high proportion of yellow birch. In addition to the usual subsequent observations and remeasurements, weather stations were established on the treated and check areas in order to determine meteorological changes resulting from this thinning operation. Although some of the yellow birch show signs of decadence, preliminary indications are that this may be held to a minimum if a fairly continuous canopy is maintained.

Based on four years of development since cutting, the net cubic volume on the treated plot has increased more than 3 percent annually, while the trees which would have been reserved on the check area under a similar

method of cutting show a net volume gain of 1.56 percent each year. Considering the entire stand on the check area (theoretical cut and reserve trees), the net percentage increase in volume is only .8 of one percent. Expressed in cords, these percentages represent an annual growth of more than four-fifths, about a half, and less than half a cord of wood, respectively.

More extensive experiments to study the results of clearcutting and selective cutting are also under way on the Bartlett Experimental Forest. On adjacent compartments, one 5-acre block has been clearcut and another selectively cut during each of the past four years. The selective cuttings have removed from 24 to 34 percent of the cubic volume. The selective cutting will be extended for three more years, but additional clearcuttings will not be undertaken until the second cutting cycle on the selection plots, which should be in about 15 years. On the areas where a partial cutting was made, the residual stand is developing satisfactorily, while the reproduction shows an increase in the growth rate as a result of opening up the stand. This type of cutting has the advantage of maintaining a large growing stock, preserving recreational aspect of the forest and minimizing fire hazard. On the clearcut areas much of the advance reproduction is killed by exposure during the first two years, but this is promptly replaced by a new crop of seedlings in which yellow birch predominates.

In an effort to combine the advantages of both the clearcutting and partial cutting practices, another compartment is to be handled on a group selection basis. The initial cutting, during the winter of 1936-37, will be confined to seven irregular groups of overmature timber, varying in size from 0.1 to 0.7 acre, and comprising from 10 to 15 percent of the area treated. It is expected that similar cuttings may be made in the same stand at intervals of 6 to 10 years. Plans are being made to initiate in 1937 a similar series of experiments on clearcutting and selective cutting on the Green Mountain National Forest, near Danby, Vermont, in order to study results under different stand and soil conditions.

In connection with removal of wood from the partial and clearcutting plots during the past two years, a detailed study was made of the operation of a portable steel cordwood chute in comparison to the use of teams. The results of this study are not yet available.

Cultural Treatments. Experimental thinnings are being made on two 5-acre sample plots in a stand about 60 years of age; on one plot, approximately 19 percent of the volume will be removed, on the other, 31 percent. This will amount to about 10 and 15 cords per acre, respectively, on the two areas. These plots are situated on one of the best sites on the Bartlett Experimental Forest and support a large proportion of thrifty white ash, sugar maple, and other potentially valuable timber trees. As it is mature, all the short-lived aspen will be removed for excelsior bolts and fuelwood at this time; otherwise, the trees will be thinned to provide optimum growing conditions for the better trees that will make up the final crop. Subsequent thinnings will be made on portions of the plots as the stand develops.

Another important problem in the management of northern hardwoods is the treatment of young stands on cutover areas. In such stands the more desirable species are often in the minority and are subject to suppression by the less valuable species and weeds. Weeding offers promise of improving the composition of these new stands and of stimulating the growth of the more desirable elements. On the Bartlett Experimental Forest, a series of 17 plots have been established to study the weeding problem in areas cut for fuelwood 4 to 10 years previously. Some of the points which these plots should clarify are: (a) period after logging when weeding will be most effective; (b) amount of freedom desirable for crop trees; (c) best method of accomplishing the weeding; (d) effect of treatment on composition and growth of the stand. The areas recently clearcut will provide an excellent opportunity for additional weeding studies on areas free from the influence of even a scattered residual stand.

In an effort to improve the form and stimulate the growth, the existing hardwood reproduction was cut back (mowed) on about four acres which had been clearcut or on which a partial cutting had been made during the past three years. Although none of the experimental mowings have been under way more than one growing season, the preliminary indications of results are quite satisfactory, particularly on the clearcut areas. A large number of the seedling sprouts are well formed and making excellent height growth. Additional experimental mowings will be made in stands prior to cutting; these should prove more economical, as there would be no slash on the ground to hamper mowing. There is a second advantage in mowing before the reproduction develops; only advance reproduction will be cut, while species which seed in immediately following the opening of the stand, such as paper birch, yellow birch, aspen, and pin cherry, will not be mowed.

Mensuration

Growth and Yield of Northern Hardwoods. The first phase of the northern hardwood project was the preparation of volume tables for the major species involved. Tables of merchantable content in cubic feet, in board feet by the International ($\frac{1}{4}$" kerf) rule, and board feet by the Scribner rule have been prepared for beech, paper and yellow birch, sugar maple, and white ash. Tables for these same species and red maple also have been prepared, showing the total volume of trees below merchantable size. Tables for cordwood in the branches and tops of merchantable trees, and tables showing volume in ties and dimension stock bolts are being completed.

Detailed data have been obtained on variations in solid contents of stacked cordwood in the northern hardwood forest. The average solid content of a standard cord of four-foot wood is 86 cubic feet. The space occupied by a cord of wood after being cut into 16-inch lengths is 14 percent less than the space occupied when in four-foot lengths. The stacked cord is a reasonably reliable measure of wood in bolts. When wood is piled with ordinary care, the variability of piling by any

one person does not amount to more than three percent of the volume of the pile, that is, if the same batch of wood is repeatedly piled by one person, the stacked volume of any one piling will be, in two out of every three cases, less than three percent more or less than the average volume of all pilings.

More than 100 plots have been established for the study of yield. These have been located in typical, well stocked, even-aged stands of various ages. These yield plots will be supplemented by records covering thirty years on other permanent plots in the region and by analysis of stand conditions on the Bartlett Experimental Forest and elsewhere.

A study of growth in the various types of New England and New York on a region-wide basis is being made to provide data which will eliminate the need of the time-consuming growth studies now made in connection with each and every management plan survey. Growth by forest types, for stands of various ages, site qualities, and densities of stocking, is to be determined. Use will be made of all suitable growth data from all sources available, including the data obtained from 3,600 trees on 90 plots in Coos County, New Hampshire, and Essex County, Vermont, during the summer of 1936, as a part of the management plan survey being made for the cooperative marketing project there.

Forest Survey. Anticipating the initiation of the forest survey in this region, the Station has cooperated with the Maine Forest Service in incorporating forest resource inventory with the type mapping of 28 towns in southwestern Maine as a Civilian Conservation Corps project. The plan of field work prepared was designed to permit the use of the area and data therefrom for the testing of methods to be used over the region as a whole. It is hoped that a suitable technique may be developed, based on aerial photographic survey, because of the completeness of record and the many uses to which aerial photographs may be put.

Protection of Forests from Fire

As a sequel to the preparation of charts for the estimation of fuel moisture in relation to meteorological conditions, a general report is being prepared in which fire weather and fuel moisture conditions will be compared for the three Northeastern forest regions in which the study was conducted. Particular emphasis will be placed on the part the forests, themselves, play in reducing fire hazard.

In the study of the basal wounding of trees by fire, data are gradually being accumulated which will make for more accurate damage appraisals. The results to date plainly indicate that fire damage is cumulative and that the total effect of such injury does not express itself for several years after burning. In this total effect delayed mortality, insect infestation, and disease infection all play important parts. In Northeastern stands (oak and red spruce cover types) the peak of delayed mortality is passed by the end of the second year after burning. In the types studied almost 50 percent of the injured trees die during this interval.

Insects of the ambrosia and bark-beetle type readily attack trees which have been weakened by fire. Such attacks are quite heavy the first few months after the trees have been injured, but only in exceptional cases do such insects cause the death of the trees. They do, however, materially reduce the quality of the wood and thus are important agencies in bringing about further losses to fire damaged trees.

Disease is also a common aftermath of fire injury. Sporophores of the sapwood rotting fungi make their appearance about three years after burning. Close coincidence of the occurrence of sporophores with the area of fire scar or discolored bark is evidence of the direct association of the infection with fire injury. The first year in which such evidences of decay are apparent, as much as 22 to 36 percent of the injured trees are infected. This number will undoubtedly increase so that in time a majority of the fire-scarred trees are likely to have their butt log decayed. This is especially serious in hardwoods, where so much of the merchantable value of the tree lies in the butt log. These findings indicate that early salvage cuttings should be made in order to forestall serious saprot in butt-scorched trees.

The study of the relationship between bark character and heat resistance of trees is yielding information of a fundamental nature. To date, bark moisture content and the character of the periderm appear to be of importance. High bark moisture content makes for more rapid inward penetration of heat through the bark tissues. This appears to be substantiated by the materially higher moisture content of the bark of such low heat-resisting species as beech and balsam fir, and the lower bark moisture content of the highly heat-resistant pitch pine. Where the periderm remains persistently superficial for a long time, as in the case of beech and balsam fir, very little protective dead bark is formed. Where the periderm is deep seated from an early age, as in the pitch pine, large masses of dead bark are quickly formed because phloem tissues as well as true cork are cut off by the periderm layers.

In order that information, which has been accumulated in the study of the effects of fire on individual trees and in the appraisal of fire losses for the forest insurance project, may be reduced to a form in which it can be used to improve current estimates of fire damage by the protective organizations, an attempt will be made in 1937 to prepare a table or a chart which will show average fire damage according to type and age class of forest growth, and intensity of fire or relative fire danger as determined from the Station's fire weather charts.

NEW WORK

Forest Genetics

A program of work in forest genetics is now being formulated by Dr. Ernst J. Schreiner, who joined the staff of the Station during the fall of 1936 to head up a new project in this field. Initial effort will be built around the hybrid poplars developed for the Oxford Paper Company by Dr. Schreiner and Dr. A. B. Stout, of the N. Y. Botanical Garden. Before other work is undertaken intensively, consideration will be given to species and problems which yield greatest promise for successful development.

Exploratory studies planned for 1937 include efforts to stimulate rooting of cuttings by chemical treatment in order to facilitate vegetative propagation of species and hybrids which do not sprout readily from cuttings. Flowering characteristics and pollen ripening will also be studied in a number of species in order to establish a satisfactory background for breeding work next year.

Forest Soil Fauna

Early in 1937 Dr. Arthur P. Jacot was appointed to the staff of the Northeastern Station to undertake work on the microbiology of forest soils. Dr. Jacot is a recognized authority in this field. His first work will be a survey of the microscopic fauna of the soils on our experimental forests, with especial consideration for the correlation of these populations with forest types and variation in growth condition. It is believed this work will be of especial significance in connection with forest plantation on areas where fertility has been depleted through cultivation, erosion, or fire.

The assignment of Dr. Jacot to this Station is the first move toward building up here the group of men specializing in the various stages of forest soil science whose research will be fundamental in character and will be of service to all other regions. Opportunities for collaboration with other workers in this field are more numerous and promising in the Northeast than elsewhere.

RECOMMENDATIONS FOR ADDITIONAL INVESTIGATIONS

The present program of the Northeastern Forest Experiment Station falls far short of dealing with all the significant phases of forestry in the region. The outstanding needs for new work are briefly outlined in order of priority in the following paragraphs.

Forest Survey

There is urgent need for a comprehensive survey of the forest resources of the region to determine for each state and for smaller economic units the quantity, quality, and location of existing supplies, the present and potential growth, the rate of depletion and consumption, and trends of utilization of forest products. Such information, when correlated with results of the national forest survey in other sections of the country is essential for determining sustained yield capacities and for long range planning aimed at industrial and community stability.

Interest in a regional forest survey is widespread. It is frequently expressed in letters from forest industries and others and has been stimulated by activities of the state planning boards. The forestry departments in New York and Connecticut both made proposals for state-wide surveys of forest resources to be financed by work relief or PWA funds. Connecticut has made aerial photographs of the entire state, and in New Hampshire there has been continuous effort to finance an aerial map for several years. In Maine, crews from four C.C.C. camps are engaged in a type mapping and forest survey project covering several towns with aggregate area of about 600,000 acres. From New Hampshire and New York demands have come in for resource and growth information to guide cooperative forest management enterprises among farm woodland owners. These can be met only in part by the activities of the Division of State and Private Forestry.

The Northeastern Station should be in position to assume leadership and exert a dominant influence in coordinating the activity of other agencies so that their efforts will be in line with standards and specifications of the national forest survey. It is certain that the results of the work will be put to use as rapidly as they can be made available.

Management of White Pine and Hemlock

Up to the present the Northeastern Station has had no regular funds for a major project in the White Pine types which constitute an important part of the forests of the Northeast. Investigations have been largely confined to incidental activity in the maintenance of a number of small plots established from 15 to 30 years ago. Recent acquisition of an experimental forest in the white pine region, active development of which cannot proceed without additional funds, makes it highly desirable that an appropriation for comprehensive forest management investigations in the White Pine and Hemlock types be obtained at this time.

One of the major objectives of such studies would be to establish the technical basis for building up and maintaining a larger growing stock of high quality timber through light selective cuttings at frequent intervals. In addition to studying various silvicultural practices such as weeding, pruning, and thinning, and learning more about factors influencing the production of seed and the establishment of natural reproduction, the work would aim to develop resistance of the forest to gypsy moth, to improve soil fertility, and to promote favorable conditions for wildlife.

Because such work would tend to expand and stabilize local forest industry and increase the income obtainable from woodlands, it would be of substantial benefit to farmers and other woodland owners. Throughout the pine region of southwestern Maine, southern New Hampshire, and central Massachusetts, assistance in this field is especially important to the many communities in which agriculture is no longer of importance, which do not have the recreational attractions of either the seacoast, lakes, or mountains, and which must therefore depend primarily upon their forest resources.

Statistics of Production, Consumption, and Distribution of Forest Products

The Northeast is characterized by a large number of small wood-using industries scattered widely in rural communities and manufacturing a great variety of products. The dense urban and industrial population of the region represents a tremendous consumer demand which local producers have difficulty in serving because of lack of adequate market information and competition from other regions.

Accurate knowledge of current trends in production and consumption for the diversified products of the forest of this region will greatly facilitate marketing, would serve as a basis for standardization of dimensions and grades, for improvement of manufacturing practices, and for the elimination of waste. Improving the channel of trade between the woodland owner and the consuming industry would stimulate organization of forest properties for sustained yield management and would be especially valuable to the farm woodland owners and the rural industries.

The proposed investigations would include a study of all important wood-using establishments as to location, regularity of operation, consumption by species, form in which wood is required, and products. An attempt would be made to correlate the changes which have taken place in recent decades in the condition of tributary forests with local and regional industrial and economic trends. The work would thus contribute in a substantial way to land use planning activities in the states concerned.

Influence of Forest Cover on Streamflow, Erosion, and Water Supply

The problem of adequate supplies of suitable water for the industrial sections of the Northeast is one whose importance cannot be overemphasized. In fact, water is likely to be the limiting factor in future

community development in much of this region. Quality of the water may be of as much importance as quantity and regularity. Turbidity, for example, not only involves cash expense for chemical treatment but may affect adversely a number of industries requiring pure water for technical purposes.

Recurrence of disastrous floods on many streams in the Northeast indicates the need for thorough study of watershed conditions to locate critical areas and to determine what measures of control or adjustments of land use may be desirable to minimize the danger from abnormally high water. Stability of streamflow is a matter of importance also in connection with the many installed and potential power developments in the region.

An appropriation is needed to make surveys, to install weirs for study of the behavior of headwater streams and to conduct related studies of the effect of various types of vegetative cover on the regularity and quality of streamflow. Intensive investigations should be conducted on at least two typical watersheds, one in the glaciated region of central New England and the other in the heavy silt-loam soils on the headwaters of the Susquehanna or Delaware Rivers in New York.

Improvement of Logging Methods, Equipment, and Organization

Organization of forest enterprises in the Northeastern region has remained remarkably static for generations. The only major changes have been those associated with the transition from cutting long logs for lumber to 4-foot wood for pulp.

Hauling over ice roads on sleds in the winter and driving of the streams have been the only method of logging in much of the region. Besides involving considerable uncertainty as to the costs of operation each year and requiring working under abnormal pressure when seasonal conditions are right, this system restricts the species which can be taken out to those which float, and involves difficult problems in providing food and supplies for men and animals on the operations. The relative inaccessability of camps under this system makes effective supervision from headquarters very difficult and discourages the use of new ideas in equipment and method.

The effects of this system extend far beyond the logging operation itself. It involves important social problems in respect to woods labor, tending to perpetuate a transient, homeless element, and discouraging permanent community life. It encourages clearcutting of all merchantable timber and limits the opportunity for intensive forest management. It makes protection from fire, insects, and disease difficult, and often renders hopeless the salvage of killed timber.

This situation makes it increasingly difficult for forest owners and operators in this region to produce timber in competition with that from more distant regions or from other countries, and tends to jeopardize the existence of important industries and reduce opportunities for gainful employment.

No comprehensive studies have been made on such matters as the proper balance between road construction to keep grades down and increased costs involved in hauling over excessive grades, effective skidding distance under varying conditions of slope and size of timber, possibilities in the use of portable chutes and power saws for pulpwood, adaptation of tractors for skidding and hauling, special devices for handling 4-foot wood, et cetera.

Experience elsewhere leads to the belief that better organization of the forests and better operating policies can be developed which will stimulate economic utilization and sustained yield management and maintain local industries in competition with products imported from other countries or regions.

FINANCES

For the fiscal year ending June 30, 1937, the Northeastern Station has had the following allotments of funds:

Regular	
Forest Management	$64,270
Forest Economics	18,000
Forest Insurance	14,300
Emergency Conservation Work	27,640
Emergency Relief Administration	48,790
Total	$173,000

In addition to the above, clerical work at headquarters has been facilitated by the employment of an average of 10 young men and women financed by the National Youth Administration, and development of the experimental forests has been carried forward by the allocation of crews of enrollees from nearby Civilian Conservation Corps camps. Assuming that regular and Emergency Conservation Work appropriations will be continued on about the same basis as at present, except that work on the Forest Insurance project in this region will be terminated, but not counting on any Emergency Relief Administration money, the following budget indicates a tentative distribution of funds among the several major lines of work for the next fiscal year.

NORTHEASTERN FOREST EXPERIMENT STATION

TENTATIVE BUDGET FOR FISCAL YEAR 1938

	Forest Economics	Forest Management	E.C.W.	Total
Private Forestry	18,000			18,000
Production Costs		1,000		1,000
Genetics		22,850		22,850
Botany - Phenology		500		500
Forest Planting		6,000	2,000	8,000
Soil Fauna		5,000		5,000
Management				
Spruce		6,500	6,000	12,500
Pine and Hemlock		4,000	2,000	6,000
Northern Hardwoods		5,000	4,000	9,000
Transition Hardwoods		650	4,000	4,650
Gypsy Moth Control		500	2,700	3,200
Mensuration				
Northern Hardwoods		6,500		6,500
Protection				
Ecological Effects of Fire		6,000		6,000
Fire Prevention		1,000	3,000	4,000
Other Minor Projects		1,000		1,000
Maps and Surveys			3,000	3,000
TOTALS	18,000	66,500	26,700	111,200

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1937 Major Project

ECONOMICS

Project

Investigation and promotion of practical methods of insuring forest properties against fire and other hazards.

Working Plans

Excerpt from Working Plan for Forest Insurance Study in the Ponderosa Pine Region of the Pacific Northwest. H. B. Shepard. February 19, 1933.

Field Work for Forest Insurance Study in the Northeast. H. B. Shepard. May 13, 1935.

Scope

The study has so far been applied only to fire losses and fire insurance possibilities. Prior to initiation in the Northeast, study of the Pacific Coast territory was completed except for publication of the report.

The insurance study itself comprises three main phases; a study of the extent and character of fire losses, a study of factors affecting variation in hazard, and a study of influences on administrative and underwriting requirements.

The study of fire loss comprises collection and compilation of fire loss statistics, supplemented by a comprehensive field appraisal of the damage done by a large number of fires, covering a wide territory and variety of conditions. In this region data on variations in hazard are not available in sufficient volume for statistical analysis and so reliance must be placed on gathering of direct testimony from a large number of forest fire wardens. The study of underwriting and

administrative factors includes such items as loss adjustment, policy form, legal aspects, general economic influences, and possible prohibitive conditions arising through excessive hazard or other adverse factors.

Status

The report on the Pacific Coast territory appeared as Technical Bulletin No. 551 in the spring of 1937.

Work on the insurance project in the Northeastern region was initiated early in 1935. One hundred and forty-nine separate burned areas have been examined in Maine, New Hampshire, Vermont, Massachusetts, New York, and Pennsylvania. Pennsylvania is not in the territory of this Station, but it is logical for it to be included in the insurance study at this time.

Assistance has been rendered in the formulation of Forest Credits legislation through a study of all physical hazards to forest properties, including insects, diseases, wind, and other destructive agencies, as well as fire, and covering all forest regions. Assistance has also been rendered the Farm Credit Administration through a study of fire hazards in naval stores operations.

Progress during 1936

Field work in 1936 included the states of Massachusetts, New York, and Pennsylvania. Collection of records of past fires was extended to New York and Pennsylvania. The data for all states have been worked up in the office and are about ready for final analysis and preparation of report.

Plans for Fiscal Year 1938

The Insurance Project will not be carried further in the Northeast. The final report will be pushed as rapidly as possible. Following completion of the work in the Northeast it is planned to undertake the promotional phase in the Pacific Coast territory. This will be a logical sequel to publication of the bulletin, since interest in forest insurance seems to be particularly active in the West at the present time.

Publications and Reports

Shepard, H. B. 1936. Fire Damage in the Northern Forest Region. Technical Note 24, Northeastern Forest Experiment Station. 2 pp., mimeographed.

_____ 1937. Forest Fire Insurance in the Pacific Coast States. U. S. D. A. Technical Bulletin 551. 168 pp., 17 figs., 24 tables.

Assignment

H. B. Shepard; Alice Stuart

ECONOMICS

Project

Cooperative management and marketing for farm woodlands.

Working Plans

Cooperstown Project: Introductory Statement; Outline of Work for 1935; Division of Responsibility for Immediate Future. C. Edward Behre. August 13, 1935.

Memorandum concerning certain aspects of the Cooperstown project. B. P. Kirkland. August 1, 1935.

Organization of an operating concern to handle forest products in the Cooperstown project. B. P. Kirkland. August 3, 1935.

Forest management methods. B. P. Kirkland. August 3, 1935.

Utilization and sales practices. B. P. Kirkland. August 1, 1935.

Plan for inventory of farm woodlands. C. Edward Behre. August 23, 1935.

Cooperstown Growth Study. L. R. Reineke and C. Edward Behre. August 1935.

Instructions for survey of markets tributary to Cooperstown, New York. C. R. Lockard. December 1935.

Objective

The objective of this project is to establish the technical basis for cooperative management and utilization of farm woodlands in order to rebuild depleted growing stocks, restore and stabilize forest industries, and afford woodland owners a greater and more frequent income.

Scope

The project resolves itself into the following lines of approach:

(a) Analysis of forest resources and present land use for a sample locality to determine, by individual ownership, the amount, kind, quality, condition, and growth rate of available timber, the relation of forest land use to other land use, and a practical system of sustained yield forest management for the forest of the locality.

(b) Development of principles for cooperative organizations particularly adapted to the management of farm woodlands on a sustained yield basis.

(c) A study of the requirements of the markets available for the products of sustained yield management in the selected locality and the facilities required to prepare the products for such markets.

(d) A study of new or altered utilization practices and methods as a means of increasing the percentage of forest growth suitable for industrial use and of widening marketing zones.

(e) A study of the specific problems in other localities in the region where such cooperative management and utilization is contemplated or is under way.

(f) The development of principles of coordinated marketing if and when a number of producing centers are in operation.

Status

An area with a radius of 15 miles centering around Cooperstown, Otsego County, New York, was chosen for the initiation of the project in 1935, because physical conditions were favorable and considerable

local interest had been built up by Mr. R. H. Rogers during the preceding five years. The area is typical of much of the farm woodland region in the Northeast. It is well located with respect to wood demanding markets and about 25 percent of the area is forested. The resident farm population is in need of benefits which sustained yield forest management can bring.

Land use maps and inventory of forest resources have been made for 130 individual farms. In the merchantable stands on these farms, trees which should be removed in a light selective cutting, designed to improve the quality and growth rate of the remaining timber, were marked. A growth study indicated that the annual growth rate on the present stand is about three and one-third percent. Ten percent of the volume in the merchantable stand was marked for cutting, the selected trees being those of poor quality or low vigor, of all sizes. If this marking is followed when cuttings are made, successive operations can be made on each area at 3-year intervals, thus placing the woodlands so handled under practical and conservative sustained yield management.

As a means of putting these practices into effect, details of a farmer-owned stock cooperative association were worked up and made available to a group of farmers which, under the sponsorship of the Cooperstown Chamber of Commerce, incorporated on December 18, 1935, as the Otsego Forest Products Cooperative Association. Starting with a small interested group, the Association has acquired 251 farmer members with about 10,000 acres of forest land, and has selected and

taken an option upon a site for the sorting, processing, storage, and shipping of forest products from the lands of its members.

The authorized capital of the Association is $100,000, of which $50,000 is preferred stock and $50,000 is common. This latter can be acquired only by those engaged in producing forest products. It is issued in part payment for products delivered to the Association, under a revolving plan which will keep control in the hands of the active producers and at the same time provide flexibility of capital. Each member has only one vote no matter how much stock he may own. Preferred stock may be issued to anyone but carries no vote. Members must agree to sell their forest products only through the Association and manage their woodlots according to good forestry practice.

In order that the Association may start operations on a sound financial basis, it has made application to the Resettlement Administration for a loan of $100,000 to finance the construction of a small, efficient processing plant and to provide necessary working capital. Actual operations have been deferred pending action upon the loan request.

A specific study has been made of the area within a 30-mile radius of Cooperstown to determine the industrial outlets for forest products. This shows by species and type the material intake of the wood-using industries available to the Cooperstown Unit, and indicates that the Unit is favorably situated in this respect.

Progress During 1936

With exception of a small amount of woodland tallying, inventory

work was discontinued during the winter of 1935-36. It was started again in the spring, and during the year 90 farms, with a gross area of about 15,000 acres, including about 3,000 acres of merchantable timber, had been marked, inventoried, and mapped for a first cutting. This brings the total farm acreage studied up to about 19,000, and the total merchantable timber area inventoried and marked for a first cutting to about 4,000. A completed summary of the data on 67 of these farms shows that the merchantable forest area on the average farm contains a total basal area per acre of 71 square feet, of which about 40 percent is in trees less than 12 inches diameter breast high. Although the remainder is of sawtimber size, only 13 percent is more than 20 inches in diameter. This indicates very clearly the need for a method of management which will tenaciously reserve and greatly augment the number of larger sized stems. It also indicates the extreme importance of establishing control of the growing stock at this particular time, for a very small increase in the percentage of large size timber will be the signal for the unleashing of another wave of destructive exploitation similar to those which have occurred in the past. Cutting with a sustained yield objective, on a 10 percent selective basis as indicated by the marking, would yield about 8,000 cubic feet of wood per farm every three years. This cubic volume will be composed of about 9,000 board feet of sawlog material and 6,000 board feet of bolt wood, tie cuts, and short logs. In addition, it will yield for home use about 30 cords of fuelwood and, if markets can be obtained, about 30 cords of round material suitable for fence posts or mine props. This yield indicates that about 250 farms will

have to be worked each year in order to yield a cut sufficient to support the contemplated processing plant.

The study of industrial markets within a 30-mile radius of Cooperstown shows that a variety of wood-using industries operating within this area consume about 15,000,000 board feet annually. Nearly two-thirds of this is produced in New York State, with about one-third originating within 25 miles of the consuming plant. Of species which grow locally, about one-half is purchased in the form of logs, one-quarter in the form of lumber, and the remainder as small dimension stock or cord wood. In addition to the industrial wood, there is a fluctuating local demand for lumber within the Unit of about 3,500,000 board feet, of which about 500,000 is produced locally. Farms are also relatively large consumers of forest products; those within the Unit use, in the aggregate, more than 3,000,000 feet of lumber per year, and about 30,000 cords of fuelwood. In addition, they use thousands of fence posts and a large quantity of sawdust and shavings in connection with their poultry and dairy business.

During the year it was necessary to work out a great many details in connection with the application of the Otsego Forest Products Cooperative Association to the Resettlement Administration for a loan of funds. Most of the information used came from the project files. The original Articles of Incorporation, By-laws, and Marketing Agreement were revised and amended so that it is believed they now stand as model instruments for this type of organization.

The Association was given aid in its education work by the Extension Services at Cornell University and the New York State College of Forestry. Mr. Cope, of Cornell, held a series of four meetings in local communities in February. Mr. Carlson, of Syracuse, spoke before a number of schools and organizations within the territory and prepared several window exhibits for the Association. Mr. Bower, of Syracuse, visited the area a number of times and gave valuable advice on many phases of the program.

A comprehensive bulletin entitled "Centralized Management and Utilization Adapted to Farm Woodlands in the Northeast" has been prepared and will be published during the spring of 1937. This bulletin deals with the basic principles involved in the program of Cooperative Management and Marketing of Farm Woodlands and includes details of forest practice and cooperative organization. The printing of this bulletin has been made possible through a joint grant of funds by the Charles Lathrop Pack Forestry Foundation and the New York State College of Forestry. In addition, an article entitled "A Practical Tree Marking Instrument", dealing with the developments in connection with the use of a spray gun for marking trees with paint, has been submitted to the Journal of Forestry for publication.

Plans for Fiscal Year 1938

a. Directly Related to the Cooperstown Unit: Work will be concentrated on the operations of the Otsego Forest Products Cooperative Association, Incorporated, when they are inaugurated, and will take the form of:

(1) Inventory of Cooperators' Woodlots: Timber tally and marking only will be continued so as to cover a major portion of the lands covered by cooperative agreements. This will not only aid the Association in its initial operations but will also give data upon which to judge future results. Farm maps will not be needed except for sketch maps made incidental to the tally.

(2) Development of Cooperative Organization: Investigative interest will be maintained in all phases of the operations. This will include studies of the problems of overhead management, control of cutting, logging, and processing, and will involve detailed production cost, method of cutting, and method of handling studies. Advice and aid will also be given on questions of plant design and construction. The Forest Products Laboratory will cooperate in this.

(3) Markets: Studies, particularly in the low grade field, will be made to determine the possibilities of marketing greater portions of the forest output than has been customary in the past. These studies will be integrated with production studies on going operations of the Association.

b. Indirectly related to the Cooperstown Unit; and directly related to the entire field of forest economics as it affects farm woodland management:

(1) Marketing and Distribution: Further studies of industrial consumption in the region will be made to determine

not only the volume requirements but also technical requirements of specific industries with the objective of developing standardized processing and merchandising practices. Financial aspects will also be studied.

(2) Prices: Sources of information on going prices of forest products will be investigated to the end that price information will be coordinated and kept up to date to supplement production and distribution cost studies.

(3) Finances: Certain financial aspects of forest industries will be investigated, with initial emphasis on a comparative study of compensation insurance in all states of the region.

(4) Other Producing Units: As other producing units are established and inaugurate operations, general contact will be maintained and supplemental studies along the lines listed above will be undertaken as needed.

c. Priorities: First priority will be given to work under Section A above. The degree to which effort is spent on Section B will depend upon the time available after the needs of Section A are filled.

Publications

Behre, C. E., and Lockard, C. R. Centralized Management and Utilization Applied to Farm Woodlands in the Northeast. To be published as a bulletin of the New York State College of Forestry early in 1937. 64 pages, 9 tables, 9 figures, illustrated.

Assignment

C. R. Lockard and C. H. Stoddard

ECONOMICS

Project

Effect of size of timber and method of cutting on costs of operation in the production of

(a) Northern White Pine Lumber

(b) Northern Hardwood Lumber

(c) Spruce and Fir Peeled Pulpwood

Working Plans

Preliminary draft of working plan for white pine logging and milling study in the Northeast. V. S. Jensen. April 30, 1934.

Plan of work for silvicultural plots in connection with selective logging cost studies. C. Edward Behre. August 21, 1934.

Preliminary draft of working plan for pulpwood production costs study in Northeast. V. S. Jensen. June 28, 1935.

Scope

To determine the best methods of logging in the Northeast from the standpoint of the lumber operator, the public, and the landowner interested in maintaining his property in a productive condition. The problem naturally falls into two phases: the first, of immediate interest to the pulpwood or lumber operator, an analysis of logging and milling costs to determine:

1. The effect of selective or partial cutting upon production costs.

2. The comparative labor involved for each step in logging trees of different diameters.

3. The comparative labor involved for each step in utilizing logs of different sizes and different degrees of soundness.

4. The difference in production costs in various forest types.

5. The amount and character of waste in logging.

6. The effect of the stand per acre on log output.

7. The effect of crew organization on efficiency.

In addition, this phase of the project affords an opportunity for the formulation of log grading rules to facilitate the marketing of timber.

The second phase of the problem deals with the management and development of the forest subsequent to logging, with particular reference to the following in various types under different methods of cutting:

1. The immediate damage to the residual stand, including advance reproduction, as a result of logging.

2. The benefits, if any, to the residual stand and reproduction coming in following logging as a result of a change in environmental conditions.

The permanent plots established in connection with the production cost studies will be handled under the appropriate forest management projects subsequent to the year after cutting.

Status

White Pine

This project was initiated in the fall of 1934 in cooperation with the Forest Products Laboratory and the Massachusetts State

College. After a survey of the white pine region in New England, six localities, Marlboro, Gilmanton, and Holderness, New Hampshire; Waterboro, Maine; and Townsend and Amherst, Massachusetts, were selected in which to carry on the study. These areas included a good range in forest types, age classes, and quality of timber, and could be handled under a variety of cutting methods. The Holderness job provided an opportunity to work in a stand of white pine which was pruned about 1910 to improve the quality of the lumber.

In deciding upon a marking policy for two of the partial cutting operations, the Station enlisted the cooperation of a group of competent foresters interested in the management of white pine.

Permanent sample plots were established in each locality prior to logging; the total area of the plots, exclusive of isolation strips, is 10.08 acres. Time studies were not restricted to trees cut on the sample plots; neither were all trees on the sample plots utilized in this phase of the work.

In connection with the logging and milling cost analysis, complete data were obtained on 2,400 trees having a total volume of about 500,000 board feet. All logs were graded, using as a basis grading rules worked up when the study first got under way. Individual reports have been completed covering each of the six operations studied.

Northern Hardwoods

In the fall of 1935 three northern hardwood operations were studied in cooperation with the Forest Products Laboratory. The three operations selected were located at Danbury, New Hampshire;

Bondville, Vermont; and Poland, New York.

A commercial selection, removing all the largest and best trees, was the basis for cutting on all operations. Experienced choppers ordinarily made the selection of the trees to be cut.

Permanent sample plots were established in each locality prior to logging; the total area of the plots was 4.35 acres. All logs were graded, using grading rules tentatively set for the purpose.

Pulpwood

This phase of the project was started during the summer of 1935 and the field work was completed in June of 1936. The study was confined to small operations in second growth stands of spruce and fir in northern New Hampshire, the owners being members of the recently established Forest Products Cooperative Association, Incorporated. In most cases the owners wished to remove all trees that would show an immediate financial return, although they were not altogether in agreement as to the most profitable method of cutting. In general, all sound trees which would yield 2 or more 4-foot sticks of pulpwood were cut, trees containing only one stick of merchantable wood being left largely as a concession to the piece work choppers. Very rough, open grown trees were left, irrespective of size.

Progress During 1936

With the completion of the individual reports on the six white pine operations, the Laboratory and the Station are collaborating in the preparation of a composite report for publication. All field work and practically all the compilation work on the three hardwood operations has been completed. The sample plots established in 1935

were retallied in order to determine the trees and reproduction cut and destroyed in logging, and the condition of the residual stand subsequent to logging.

On the pulpwood study all field work was terminated July 1. In the course of this work two one-fifth acre demonstration areas were established. On one plot a relatively light partial cutting removed about 50 percent of the volume; on the adjacent area a heavy cutting included practically all trees that contained merchantable pulpwood. The preliminary compilation work has been largely completed for all phases of the study except falling and peeling.

Plans for Fiscal Year 1938

The composite report covering all white pine operations will be published and distributed.

Reports of each of the three hardwood operations will be completed at the Forest Products Laboratory. The Experiment Station will complete the analysis of data on the pulpwood operations and prepare a report covering all the work done. Field work will be restricted to observations on the established sample plots.

Publications and Reports

Forest Products Laboratory. 1935 and 1936. White Pine Production Cost and Method Studies in New England. Study No. 1, Marlboro, New Hampshire. 25 typed pages, 19 tables, illustrated.

Study No. 2, Gilmenton, New Hampshire. 25 typed pages, 20 tables, 6 figures.

Study No. 3, North Waterboro, Maine. 23 typed pages, 22 tables, 6 figures.

Study No. 4, Holderness, New Hampshire. 23 typed pages, 22 tables.

Study No. 5, Townsend, Massachusetts. 22 typed pages, 20 tables, 3 figures.

Study No. 6, Amherst, Massachusetts. 21 typed pages, 22 tables.

Benson, A. C. 1937. The Production of Lumber from Northeastern Hardwoods. Methods, Costs, and Values. Study No. 1, New Hampshire. 44 typed pages, 59 tables, illustrated.

_____ Study No. 2, Vermont. 32 typed pages, 52 tables, illustrated.

Assignment

Forest Products Laboratory, A. C. Benson; Northeastern Forest Experiment Station, Victor S. Jensen.

GENETICS

Project

Forest Genetics.

Working Plans

Comprehensive Project Analysis and Plan of Work in course of preparation.

Objective

Improvement of forest trees from the standpoint of both silvicultural and utilization characteristics.

Scope

It is planned to concentrate work in the Northeastern region on the improvement of broad-leaved species. Some work with native conifers may, however, be included, particularly with respect to developing resistance to attacks of insects and disease.

Initial effort will be based on the hybrid poplars developed by the Oxford Paper Company in cooperation with the New York Botanical Garden. With this as background, a survey of other native species will be made to select those with which additional breeding and improvement work will be undertaken. Development of technique for crossing within and between the species selected will precede actual hybridization. Cytological studies will be undertaken to establish the genetical characteristics of new hybrids. Studies of the physiology of vegetative propagation will constitute an important aspect of the project. Attention will also be given to studies of seed origin and to tests of the progeny of individual trees exhibiting outstanding

qualities.

Status

Detailed plans for the project are being prepared. Messrs. Snow and Marco have been assigned to assist Dr. Schreiner in studies of vegetative propagation and cytology of some of the Oxford Paper Company's hybrid poplars.

Progress During 1936

Dr. Schreiner prepared a review of research in forest genetics in the United States for the 1937 Yearbook of the Department of Agriculture. He also visited most of the forest experiment stations, and other institutions where work in forest genetics is under way, to obtain a more intimate and comprehensive background of the field and its techniques.

Plans for Fiscal Year 1938

It is anticipated that work will be along the general lines indicated below:

1. Work with Hybrid Poplars

Certain phases of the project started in 1924 by the Oxford Paper Company for the production of fast growing poplar hybrids will be continued by the Northeastern Station. These hybrids will be evaluated to determine their suitability for forestation or other purposes. Since cutting stock will not be available for field trials in the spring of 1937, the primary effort in this direction will be to put the Oxford nursery into a condition to produce sufficient cuttings for test plantings in 1938.

If possible, the physical and chemical properties of the wood will be considered in selecting individual hybrids. At present, adequate tests for such properties, based on small samples, are not available, and it will be necessary to devise suitable methods for evaluating wood quality in these trees.

Many of the new hybrids have already produced flowers and it will now be possible to make second generation crosses between these trees. Cytological investigations will be started to indicate the best possible combinations for such second generation crosses.

There are a number of hybrids between species of the white poplar and aspen groups which do not root readily from cuttings. The wood of these trees seems especially well adapted to the production of matchwood and veneer. Physiological studies to develop methods of vegetative propagation for these hybrids will be undertaken. The results will be applicable not only to the poplars but to any new hybrids which may be produced in the future. If successful methods for vegetative propagation can be developed for species or hybrids which cannot be economically rooted from cuttings, many years of selective breeding can be saved with individuals which are of outstanding value for forestation purposes.

2. Seed origin

This work, which is of very considerable importance from the standpoint of reforestation at the present time, will be handled in collaboration with the planting project. The experimental work will aim to determine the best source of seed of various forest tree species for use in the Northeastern region.

3. Individual tree progeny test

The value of an individual for propagation purposes can be determined only from a test of its progeny. At the present time, some work of this nature is justified because it will provide criteria for inherent excellence which is necessary to the silviculturist handling forest stands under a selection system. It is also of value in determining the type of trees best suited for seed tree purposes. Individual seed tree progeny tests will be tied in more or less directly with the breeding and selection work which is to be carried on. An arboretum will be established on the Hopkins Memorial Experimental Forest.

4. Improvement of forest trees through breeding and selection

Initial effort with species other than poplar may be outlined as follows:

a. Preliminary work will be undertaken to determine which species should be given priority. This will entail a survey of native species and their potential importance from the standpoint of forestation, including the improvement in silvicultural or utilization characteristics desired.

b. Preliminary work designed to develop technique for crossing within and between important forest species. Before an extensive breeding program can be undertaken it is necessary to know something of the flowering habit, time of bloom and receptivity of the female organs of the flower, pollen shedding and viability, pollen storage methods, effect of bagging on flower and seed production, et cetera.

c. Hybridization between species. Hybridization work between important species of our native forest trees will be started as soon as possible. Aside from its value in providing the technique for future hybridization and breeding, the seedlings resulting from such crosses may be of special value. Hybrids often exhibit more vigorous growth than either of their parents and, with vegetative propagation, such valuable individuals can often be propagated and their characteristics perpetuated without further breeding work.

Publications and Reports

Schreiner, E. J. Improvement of Forest Trees. U. S. Department of Agriculture Yearbook, 1936. 50 pages, typed, 43 pages of bibliography; 40 pages of appendix; illustrated.

Assignment

E. J. Schreiner, H. F. Marco, A. G. Snow

FORESTATION

Project

Forest planting in the Northeast.

Working Plans

A working plan for studies of reforestation in the Northeast. G. R. Stewart. November 16, 1931.

A working plan of cooperative planting of Scotch pine. G. R. Stewart. April 9, 1932.

A revised working plan for the study of reforestation in the Northeast. G. R. Stewart. September 22, 1932.

Planting and working plan for Chenango Experimental Forest, Otselic and Smyrna, New York. G. R. Stewart and H. F. Morey. November 14, 1933.

Working plan for the poisoning of weed tree species at the Chenango Experimental Forest. G. R. Stewart. December 28, 1934.

Forest planting problems in the Northeast, C. E. Behre, April 27, 1934, with memorandum on program of work, May 1, 1934.

Scope

Studies in the scientific basis of forest planting in the Northeast along the following lines:

1. Methods of planting, aimed at increasing success and reducing the cost of forest planting.

2. Problems relating to the establishment of mixed plantations.

3. Methods of reforestation for areas of poor drainage or heavy competition.

4. Incidental attention to questions relating to source of seed from two angles.

   (a) Development of uniform system of nursery records for identification of the source of seed in each plantation.

(b) Testing adaptability of promising strains of desirable species.

5. Fertilizer response in young plantations.

6. Integration of forest planting with wildlife management.

Status

The initial work on the project placed major emphasis on the development of planting technique which would increase the success and reduce the cost of forest planting work. During 1931 and 1932 extensive surveys throughout the region of plantations representing a wide variety of ages, mixtures, and sites, yielded considerable data on their general condition as well as a frequent explanation of their failure or success. This survey was supplemented in 1932 by studies of planting technique and costs in which staked rows were set out in various planting jobs to follow survival, growth, and vigor under different conditions. In 1933, 127 permanent plots were set out on the Chenango Experimental Forest near Smyrna, New York, and at North Branford, Connecticut, to study the effect of depth and method of setting trees upon the survival and root growth. A further group of 48 plots was set out in 1934 at the Chenango Forest as a part of the same study.

Problems relating to the second objective, establishment of mixed plantations, are being concentrated on the Chenango Experimental Forest. The extensive survey of plantations mentioned above, however, contributed considerable data on the problem. Numerous group plantings in pure and mixed groups, strip plantings, and interplanting have been undertaken on the Forest. Direct seeding in sod and in

plowed furrows has also been undertaken.

Reforestation of wet lands, which revealed itself as an important problem in the course of the extensive plantation survey, is now receiving detailed study on the Chenango Forest. Here, experiments have been started in surface drainage. Detailed ecological studies have been made of certain wet portions of the forest where survival of planted stock was noticeably very low. In addition, test plantings have been made of small amounts of yellow birch, white cedar, swamp white oak, black ash, and white ash. Further plantings of other moisture tolerant species will be made in connection with this work.

In order to build up adequate knowledge of the effect of source of seed, efforts are being directed to the adoption by nurseries of an improved form providing for a continuous record of nursery stock from seed to plantation. Experimental plantings, throughout the region, of stock of promising strains have been initiated, and this is being supplemented on the Chenango Forest by comparative plantings of stock grown from seed gathered locally as opposed to stock grown from seed obtained in different climatic zones.

Studies of fertilizer response in young plantations is a new phase of the planting project for which preliminary plans have been prepared, but on which no work has been done.

Correlation of forest planting with wildlife management is a matter deserving attention for which plans have not yet been prepared. Such studies would consider not only the question of

maintaining cover and food supplies to support desirable forms of wildlife, but would also involve prevention or reducing of damage to plantations by rodents.

Results

The findings of this project to date may be summarized as follows:

1. Trees planted in dug holes with roots spread show distinct superiority to those set in slits without cultivation. Three factors are probably responsible for the high survival in the dug hole method: (1) removal of local competition, (2) cultivation of the soil, (3) excellent spread of root system attained.

2. Trees set very low result in lower survival than those set high or slightly low. Extremely low planting results in root decay and often the ultimate death of the tree. Recent observations indicate that, should the tree survive the early sloughing off of the root hairs, it may eventually put out new roots and continue its growth at a slower rate than trees planted at more optimum depths. Red pine appears less sensitive to low planting than white pine, white spruce, and Norway spruce.

3. Frost heaving represents a much more serious planting problem in New York State than in New England.

4. Survival of planted stock is low in damp lands, due to excessive soil moisture and keen competition of grass and herbaceous growth.

5. An index to the degree of soil saturation, and hence suitability for planting, may be found in the extent to which certain moisture tolerant plants are present.

6. Early spring planting, particularly in New York State, generally gives highest survival.

7. Because of the wide variability of site conditions throughout the region, adaptation of species to site conditions is an important consideration.

8. High mortality and loss of vigor of trees grown from seed obtained from unsuitable climatic zones emphasizes the importance of ascertaining the seed source of both native and foreign species used in planting.

9. Good development and survival of large stock emphasizes the importance of using this class of stock on areas of high planting hazard in preference to seedling stock. This is particularly true of conifers.

10. Superior survival and growth occur on well drained sites where sod competition is removed, as demonstrated in the ploughed furrow experiment.

11. Best results with direct seeding have been obtained where sod cover is removed and seed planted in mineral soil to a depth equal to the longest axis of the seed. It is essential that well drained sites be chosen.

Progress During 1936

Accomplishments during 1936 may be summed up as follows:

1. Completed the planting of all of the White Pine 2-2 stock and 925 trees of White Pine 2-1 stock in the group planting experiment.

2. Filling in the widely spaced White Pine plantation, which was done by direct seeding of hardwoods in 1935, was extended to include interplanting of seedlings of the same species, namely, white ash, sugar maple, red oak, black cherry, basswood, and black locust. Inasmuch as the seedlings were obtained from various sources, this planting should yield some information on the questions relating to seed source.

3. The alternate strip method of establishing mixtures was extended into compartment 4, where 7,000 White Pine 2-2 were planted in 10- and 5-row strips alternating with 10- and 5-row strips of black cherry and sugar maple. Owing to a lack of basswood stock, no strips of this species were planted, but the vacant strips were laid out for planting at a future date. The scheme involved closely parallels that used in the strip planting in compartment 3, where black locust, sugar maple, and white ash were planted with white pine.

4. Test plantings were made of several moisture tolerant species to determine their adaptability on moist, poorly drained sites given over to heavy grass and herbaceous growth. These species were as follows: yellow birch, swamp white oak, black ash, white cedar.

Encouraged by the success obtained in an earlier plantation of white ash on moist land, a much larger planting of white ash was made this year. Here white ash stock of two different ages and from three different sources was used.

An extremely moist area, on which surface drainage ditches had been dug and on which a planting of 2-0 seedling stock of eastern hemlock had failed, was replanted with 3-0 seedlings.

Another area where an earlier planting of spruce had met with heavy mortality was replanted with 2-2 Norway spruce stock.

5. Remeasurement of Branford, Connecticut, method and depth of planting plots.

6. A total of 121 permanent sample plots were established in the 1936 plantations, and all plots previously established were remeasured on the Chenango Experimental Forest.

7. Root examinations were made on all of the 2-1 plantings in the method and depth plots established in 1933. Early freezing of the ground prevented the extension of this work.

8. Four small experimental plots were established in heavy willow growth and in raspberry growth. Here the effectiveness of Atlacide as a weed and shrub killer is being tried out. The poison was sprayed on with Indian fire pumps. Early observations indicate that its use in this fashion is quite effective. The leaves on all growth withered and dropped off after a few days. At least two seasons will be necessary before definite conclusions can be reached.

Plans for Fiscal Year 1938

Pending opportunity for Mr. Sims to review the entire situation, plans for 1938 are limited to carrying forward the work on the Chenango Experimental Forest necessary to meet objectives of the experiments under way. This includes refilling failures in a number of the earlier plantings, extending the group mixture plantings and the tests of moisture tolerant species in wet places, weeding some of the planted area, remeasuring sample plots, and completing examination of root development in the method and depth of planting experiment.

In addition, it is proposed to fill a portion of the areas partly occupied by scrub apple and willow with group plantings of white pine and Norway spruce. In the fall, collections of seed of local hardwoods

will be made for future use on the Forest.

Assignment

I. H. Sims and F. E. Cunningham

MANAGEMENT

Project

Management of spruce types. (M-1)

Working Plans

General Working Plan. M. Westveld. January 22, 1932.

Cutting:

Establishment of Method of Cutting Plots 59-62. M. Westveld. August 1924.

Outline of reproduction and growth study on cutover spruce lands. M. Westveld. April 14, 1926.

Establishment of Mc Plots, Cherry Mountain, No. 99-118. M. Westveld. June 29, 1930.

Reproduction:

Study of factors affecting reproduction on cutover spruce lands. M. Westveld. July 1, 1926.

Reproduction study on burned over spruce lands. M. Westveld. May 24, 1927.

Study of logging damage to young growth. M. Westveld. August 23, 1929.

Girdling:

Establishment of the Depot Camp Waterville girdling plots. M. Westveld. April 1, 1930.

Weeding:

Establishment of weeding plots. M. Westveld. April 4, 1930.

Thinning:

Establishment of thinning plots. M. Westveld. March 17, 1926.

Establishment of Cherry Mountain thinning plots 109-114. M. Westveld. November 13, 1930.

Swamp Drainage:

Plan for study of swamp drainage. Koulichkov, Belotelkin, and Washburn. April 1934.

Scope

To determine the best methods of regenerating, improving the quality, and increasing the yields in the various spruce types of the region. The project includes studies in (1) methods of cutting; (2) natural reproduction; (3) slash disposal; (4) thinning; (5) weeding; (6) pruning; (7) girdling; (8) releasing; (9) poisoning; (10) drainage; (11) forest soil types; (12) management problems on experimental forests.

Status

Numerous temporary plots established during the early stages of the study in stands varying widely as to age and composition, together with permanent sample plots representative of the spruce types in the region, form the basis of the study. Distribution of the permanent sample plots among the various phases of the study is as follows:

Phases of Study	Number of Plots	Area in Acres
Methods of cutting	153	175.400
Natural reproduction	202	Small quadrats
Slash disposal	14	31.950
Thinning	10	3.400
Weeding	10	3.250
Girdling	16	94.000
Releasing	16	3.100
Poisoning	93	5.262
Drainage	48	.192
Soil types	Wells on numerous permanent plots	
Planting	47	4.700
Total	609	321.254

In addition to the small quadrats listed above, natural reproduction is being studied on some 1,000 chains of reproduction transects located on various permanent sample plots.

Results

Early efforts were directed to determining the basic principles for successfully regenerating spruce stands in the principal spruce types of the region. Broadly speaking, spruce stands may be segregated into two classes: (1) those of most common occurrence which can be easily regenerated through relatively simple and inexpensive measures; (2) those less abundant as to area, consisting of (a) dense, even-aged stands of immature spruce and fir, and (b) stands with strong admixtures of hardwoods, in which regeneration presents a difficult problem. The technique for successfully regenerating stands falling in the first class has been largely solved. These usually have an abundance of advance reproduction to work with. Successful management lies mainly in protecting the young growth from logging damage, from subsequent windthrow and fire, and from excessive shading and crowding by hardwoods. The problem of how to regenerate spruce stands falling in the second classification is less simple. In such stands reproduction is generally absent or deficient. Studies so far indicate that they should be given a light initial cut removing one-fourth to one-half the stand, permitting the establishment of reproduction under the shelter of the remaining trees. Ten to fifteen years later when reproduction is fully established, the remainder of the old stand may be cut.

Efforts in recent years have been directed to the accomplishment of two additional objectives: (1) increasing the growth rate of spruce; (2) improving its quality. Of the measures developed for accomplishing

the first objective, the most effective so far devised is girdling defective hardwoods to favor the spruce component in mixed stands. Experiments indicate that girdled lands can be made to produce pulpwood several times as rapidly as similar ungirdled areas. The striking results obtained from experiments in girdling have given impetus to its general adoption as a stand improvement measure in the region.

Spruce thinning experiments indicate that thinning old field spruce stands is a practical measure both from the yield and regeneration standpoints. Analysis of data obtained over a period of 30 years from plots established in a 55-year-old pure spruce stand showed an average annual increment of 61.8 cubic feet per acre on the thinned plot, in contrast to an average annual loss of 6.1 cubic feet per acre on the unthinned plot. In contrast to a total absence of any coniferous reproduction above 0.5 feet in height on the control plot in 1935, the thinned plot supported more than 2,800 trees per acre between 0.5 and 2.0 feet in height.

Construction of drainage ditches in 1934 in a 200-acre spruce swamp on the Gale River Forest resulted in lowering the water table level approximately six inches during the period May 1 to December 1, 1935, but there has not yet been time to note any effect on growth rate.

Experiments in weeding of young spruce stands and thinning at later stages are under way. In a compartment of 80 acres on the Gale River Experimental Forest, selective pruning of crop trees has been carried out to increase quality of the spruce sawtimber yield.

Experiments in poisoning and girdling undesirable trees have met with varying degrees of success. Used in strong enough solution, both sodium arsenite and Atlacide (largely commercial sodium chlorate) effectively kill the stems of trees, but fail to kill their root systems, permitting the latter to send up root suckers or basal sprouts. Sodium arsenite is more effective than Atlacide. On the other hand, girdling of certain species, particularly aspen, not only kills the trees but also eliminates subsequent suckering or sprouting to a large extent.

A statistical analysis of some 400 growth plots established on cutover spruce lands has resulted in the development of an equation for estimating future production of cutover spruce lands. Volume of spruce and fir is expressed as a function of time, density, and composition. This work will be of value in planning sustained yield management for spruce tracts.

Progress During 1936

Accomplishments during the year 1936 may be summed up as follows:

I. Work on the Gale River Experimental Forest

A. Cultural Operations

(1) Cuttings

Cutting of five hundred and fifty cords of hardwoods in sawtimber compartment to release spruce and fir. The cordwood cut in this operation is being used as fuelwood at the Civilian Conservation Corps Camp Gale River.

Cutting of a portion of a mature white birch stand to release an understory of established spruce and fir. Total amount sold--255 cords, with a value of $297.50.

(2) Planting

Replacement planting of 3,000 white cedar and 2,000 white spruce; white cedar between Trudeau road and railroad grade, white spruce west of railroad grade.

Planting of 7,000 white cedar under alder growth of different densities in the swampy or moist areas east of Trudeau road and south of 1934 plantations.

Planting of 6,000 white spruce on more open and drier sites in the same general location with white cedar.

Planting of 500 white pine and 500 Norway pine 3-year-old root pruned seedlings.

(3) Pruning

Spruce crop trees pruned on 50 acres between the railroad grade and northeast road. Average number of trees pruned per acre, 64; height of pruning, 17 feet. Trees which held highest promise of furnishing high grade lumber were favored, i.e., vigorous, but not too large.

(4) Girdling

Aspen and associated species on plots established in 1935 were girdled to determine the effect of girdling undertaken at various seasons of the year on subsequent root suckering of these species. No effect, so far as apparent vigor is concerned, was discernible during the summer as a result of the girdling. In the fall the foliage on the girdled trees turned yellow and fell about two weeks earlier than the leaves on the check plot. No difference was noticed on plots treated between September 1935 and April 1936. Trees on plot girdled June 13 shed their leaves about a week later than the balance of the treated plots.

B. Establishment of Permanent Sample Plots and Remeasurement Work

Establishment of 8 plots in 1936 spring plantations.

Establishment and tallying of milacre transects on the spruce thinning plots to study the eventual establishment and development of reproduction in immature stands under different degrees of thinning.

Remeasurement of 32 quarter-acre plots in the sawtimber compartment following release cutting of hardwoods to free the spruce understory. A hundred percent tally

was made of the stand. Reproduction was tallied and ground cover recorded on milacre transects.

Tallying of pruned trees on 30 one-quarter-acre plots in area between the northeast road and the railroad grade road.

Bi-weekly counts on 14 quadrats to follow survival of 1935 crop of balsam fir and red spruce seedlings.

ReExamination of 47 plots in the 1933 and 1934 plantations.

II. Other Experimental Work

The following permanent sample plots elsewhere in the region were remeasured in the course of the year:

1. Sixteen spruce increment plots near Rockwood, Maine.

2. One 1-acre girdling plot at Bolton, Vermont.

3. Complete or partial remeasurement of ten 5-acre method of cutting plots at Mount Deception near Fabyan, New Hampshire.

4. Three 3.6 acre slash disposal plots at Cherry Mountain, New Hampshire.

5. Tallies maintained on seedbed condition plots at Cherry Mountain, New Hampshire.

A start was made last year in what was planned to be an extensive study of spruce burns throughout the spruce region. Owing, however, to the urgent need for information regarding reproduction and growth conditions following cutting of old field spruce stands in connection with the Coos-Essex County Cooperative Project, the spruce burn study was temporarily abandoned and work concentrated on a survey of old field spruce cuttings. A total of 112 plots, aggregating 14.8 acres, was established in the course of the season. Analysis

of the data collected should develop principles for successful management of old field spruce stands on a sustained yield basis.

Plans for Fiscal Year 1938

No changes are contemplated in the general orientation of the work.

The following plots will be remeasured in the course of the year:

1. Seven spruce increment plots at Lily Bay, Maine.
2. Four weeding plots at Cherry Mountain, New Hampshire.
3. One 1-acre girdling plot at Bolton, Vermont.
4. Five girdling plots at Waterville, New Hampshire.
5. Four method of cutting plots on Gale River Forest.
6. Four spruce thinning plots on Gale River Forest.
7. Four spruce increment plots at Pittsburg, New Hampshire.
8. Six release cutting plots on Gale River Forest.
9. Two girdling plots on Gale River Forest.
10. Seven method of cutting plots at Sherburne, Vermont.
11. Three slash disposal plots at Plainfield, Vermont.
12. Two method of cutting plots at Battell Forest, Vermont.
13. Two 5-acre girdling plots at Newcomb, New York.

Plans call for removal of hardwoods on approximately 25 acres in the sawtimber compartment on the Gale River Forest. A light cutting of mature balsam fir on this and adjacent compartments will be made if a market for pulpwood can be obtained. All cruise plots falling within newly cut areas will be measured to follow the development of the residual stand. Pruning of crop spruce trees will be undertaken on an additional 50 acres of the Forest. Small sales of stumpage for pegwood and other products will be made to demonstrate various cutting and cultural methods to meet the silvicultural needs of the stands and accomplish the objectives of management prescribed for the various timber types.

It is hoped that arrangements may be made for initiating a series of light selective hardwood cuttings on the Finch Pruyn Experimental Forest to study the effect of such a system on the proportion of spruce and fir on the stand, on the character and quantity of growing stock, and on average annual yield.

Publications and Reports

Snow, A. G. 1936 Progress Report on Spruce Thinning Plots at Corbin Park, New Hampshire. 46 typed pages.

_____ 1936 Preliminary Report on Reproduction and Growth Studies on Cut-over Old Field Spruce Lands. 80 typed pages.

Spaulding, Perley. Estimating the Length of Time That Trees Have Been Dead in Northern New England. Journal of Forestry 35(4): 393-395. April 1937.

Westveld, M. 1936. Increase Production of Spruce by Girdling Hardwoods. Forestry Chronicle 12(2): 125-127, 1 figure. (Also appeared as Technical Note 23, Northeastern Forest Experiment Station.)

_____ 1937. Increasing Growth and Yield of Spruce Pulpwood Stands by Girdling Hardwoods. U. S. D. A. Circular 431. 20 pp., 18 tables, 3 figures, illustrated.

Assignment

M. Westveld, Perley Spaulding, Hugo Kraemer, and K. T. Belotelkin.

MENSURATION

Project

Growth and management of northern hardwoods (ME-3).

This project has been subdivided into its two major components: (a) growth and yield; (b) methods of management.

A. Growth and yield of northern hardwoods (ME-3).

Working Plans

Plan of work: Growth and yield of northern hardwoods. C. E. Behre. January 19, 1932.

Supplementary plan of work: Collection of data for volume tables. C. E. Behre. January 19, 1932.

Cordwood Piling, Coos County, New Hampshire. L. H. Reineke. November 17, 1933.

Scope

In the management of any area of forest land for the continuous production of lumber or other forest products, it is necessary to know the various kinds, sizes, and quantities of forest products which will be produced within a given period of time so that management can be directed toward maximum value return and cutting will not exceed production. It is the purpose of this phase of the project to provide the factual information required for this production control.

Status

Old measurements of some three thousand hardwood trees were available for volume studies. These measurements were transcribed to new forms to facilitate their use in the preparation of volume tables.

Tables of merchantable volume in cubic feet, board feet by the Scribner rule, and board feet by the International rule were prepared for beech, paper birch, yellow birch, sugar maple, and white ash. Tables for total cubic volume of stem and branches have been prepared for these same species and for red maple also.

Trees removed in thinnings on the Bartlett Experimental Forest have been measured for volume table and cordwood study purposes. Complete measurements have been made on 308 trees for volume purposes, and 77.5 cords of hardwood have been measured in a study of variability in piling. Each pile was broken down and repiled five times in both four-foot and stovewood lengths to ascertain the variation in the piling of individuals and variation between pilers. Data were derived from these same measurements on the solid contents of stacked cordwood and the effect of bucking into shorter lengths on solid contents.

Improvements in the technique of growth and stand inventories for management plans and yield studies have been made. Growth data from the Bartlett Experimental Forest survey and the White Mountain National Forest survey have been analyzed to determine the reliability of the field work. The results have been used to prevent unnecessary accumulation of growth data in the course of field work. Hardwood growth measurement has been simplified by the design of an increment core examining device. Cores are held by the instrument and shaved off on both sides, giving a thin section readily transmitting light and thus rendering the growth rings quite distinct. No dyes or stains are used, and the device can be used in the field as simply as the

increment borer itself.

For the prediction of growth, much basic data were accumulated in the intensive survey of the Bartlett Experimental Forest, completed in 1932. Records covering thirty years on sample plots at Pomfret, Sharon, and West Rochester, Vermont, and at Corbin Park, New Hampshire, will contribute further to growth and yield analyses. Records for fifteen years on fourteen plots at North Berwick, Maine, are at hand. These latter plots have been discontinued, having been heavily cut over by the owner.

For the study of yield in even-aged, second growth stands, 45 semi-permanent, intensive, and 111 temporary sample plots in Maine, Vermont, and New York were measured in 1933 and 1934. The intensive plot measurements include data on form, defect, and merchantability.

Progress During 1936

No new sample plots for yield were established. Three semi-permanent, intensive plots in Vermont were lost through cutting by the owner. This loss is not serious, since the growth of only two seasons was involved.

Some two thousand increment cores from trees on fifty-five of the plots measured in Coos County, New Hampshire, and Essex County, Vermont, (Project ME-2), are available for use in studies of hardwood growth. These will be combined with growth data from the Gale River and Bartlett Experimental Forests, the White Mountain management plan survey, the Cooperstown project, and other sources, in order to derive region-wide growth rate figures which will eliminate the necessity of making detailed growth studies on future management plan surveys.

Computations have been continued for the cordwood study and for the volume tables for ties and dimension stock.

Plans for Fiscal Year 1938

Twenty semi-permanent sample plots established in 1932 will be given their first remeasurement. Additional temporary and semi-permanent yield plots will be established in even-aged, second growth stands, particularly in New York. Attention will be given to the estimation of time since death from the appearance of the dead trees, in order to test and supplement rules prepared in 1936 by Dr. Spaulding. For use in connection with the regional growth study, the plots of the Bartlett Experimental Forest survey will be reExamined for mortality since establishment. Computations will be completed for the tie and dimension stock volume tables, and the results of the cordwood study will be prepared for publication.

Patent applied for: Reineke, L. H. On an "Increment Core Holding and Examining Instrument."

Assignment

L. H. Reineke

MANAGEMENT

Project

Growth and management of northern hardwoods (ME-3).

B. Methods of Management in Northern Hardwoods

Working Plans

Plan for weeding experiments on the Bartlett Experimental Forest. V. S. Jensen. May 24, 1933.

Plan for clear-cutting and selection cutting experiments on the Bartlett Experimental Forest. V. S. Jensen. May 25, 1933.

Memorandum on selection and clear-cutting on the Bartlett Experimental Forest. V. S. Jensen. April 18, 1934.

Scope

This phase of the project includes experiments in weeding, thinning, and selective cutting to improve quality and quantity of the yield, requirements of the various species for reproduction and growth, effect of partial cutting on the residual stand and on reproduction, decay of slash and improved methods of moving products from the woods. Special consideration is being given to building up and maintaining a growing stock suitable for the production of high quality sawtimber of large size.

Status

The work on the management of northern hardwoods project is largely confined to the Bartlett Experimental Forest, a 2,600 acre tract occupied largely by various aged stands of this forest type. An inventory of a grid of permanently marked plots, tallied during 1931 and 1932, is the basis for all management work on this forest.

In 1932 a pair of thinning plots was established in an even-aged northern hardwood stand containing a high proportion of yellow birch. These plots were established primarily to determine the degree of thinning that might be practiced without adversely affecting the birch in the residual stand. In addition to the usual subsequent observations and remeasurements, weather stations were established on the treated and check areas in order to determine meteorological changes resulting from this thinning operation. Although some of the yellow birch show signs of decadence, preliminary indications are that this need not prove serious. Based on four years' development since cutting, the net cubic volume on the treated plot has increased more than 3 percent annually while the trees which would have been reserved on the check area under a similar method of cutting show a net volume gain of 1.56 percent each year. Considering the entire stand on the check area (theoretical cut and reserve trees) the net percentage increase in volume is only .8 of one percent. Expressing the same data in square feet of basal area rather than percentages, the increases per acre were 2.19, 1.27, and 1.04 square feet on the thinned plot, the theoretical reserved trees on the check area, and the total stand on the check area, respectively. Assuming a very conservative conversion factor of two and one-half square feet of basal area for one cord of fuelwood, the thinned area is increasing in volume at the rate of more than four-fifths of a cord per acre per year.

Seventeen tenth-acre and four quarter-acre intensive permanent sample plots have been established on the Bartlett Experimental Forest for a study of weeding in young stands of hardwoods. In addition to

the intensive plots, extensive weeding operations to liberate and stimulate the growth of desirable tree species were made on approximately 100 acres.

A large scale experiment to compare clear-cutting with selective cutting has been under way for four years. From 24 to 34 percent of the volume is removed from 5 acres of one compartment each year, while in an adjacent compartment 5 acres have been clear-cut for three succeeding years. Selective cutting will continue at this rate until a total of 30 acres has been worked, but the clear-cut area will not be extended until the beginning of the second cutting cycle on the selectively cut plots, which should be in 10 to 15 years.

A 20-acre compartment of all-aged northern hardwoods is to be worked over on a group selection basis, cutting about 10 to 15 percent of the area in irregular groups at intervals of about six years.

Experiments in thinning of a promising 60-year-old even-aged stand of northern hardwood have also been initiated, treating the area with two intensities of cutting, the cut on one 5-acre plot averaging 19 percent of the volume, and on the other 31 percent.

In an effort to improve the form and stimulate the growth, the existing hardwood reproduction was cut back (mowed) on about four acres which had been clear-cut, or on which a partial cutting had been made during the past three years. Although none of the experimental mowings have been under way more than one growing season, the preliminary indications of results are quite satisfactory, particularly on the clear-cut areas. A large number of the seedling sprouts are

well formed and making excellent height growth. Additional experimental mowings will be made in stands prior to cutting; these should prove more economical, as there would be no slash on the ground to hamper mowing. There is a second advantage in mowing before the reproduction develops; only advance reproduction will be cut, while species which seed in immediately following the opening of the stand, such as paper birch, yellow birch, aspen, and pin cherry, will not be mowed.

Tests have been made of the transportation of cordwood to loading decks by portable steel chute and use of the Wolf gasoline engine driven chain saw for felling and bucking cordwood.

Progress During 1936

Weather data and observations on the development of the stand were continued on the birch thinning plots.

In connection with the comparison of clear-cutting and selection cutting, a check plot was established on which the stand was marked in the same manner as the 26 acres selectively cut. An additional 5-acre block was cut selectively; half of the area making up a permanent sample plot. In order to supplement data obtained in the winter of 1935-1936, a portable steel cordwood chute was used to transport part of the fuelwood cut. Experimental mowing operations before and after the 1936 growing season covered portions of six partial and clear-cutting plots cut over during the past three winters.

Two 5-acre thinning plots referred to above were laid out, marked, and treated. Check areas will be established for these plots early in 1937. In the group selection experiment, 7 irregular plots

varying from 0.1 to 0.7 acre in size were laid out for the initial cutting. Another 7 plots were laid out as checks on the development of reproduction. These will be cut when the second operation is made in this compartment.

The routine examination of slash plots was continued by Dr. Spaulding, emphasizing the ecology of the slash-rotting fungi and conditions existing in the rotting slash.

Plans for Fiscal Year 1938

Routine observations and remeasurements will be continued on permanent plots on the Bartlett Experimental Forest. An additional 5-acre block, containing a two and one-half acre sample plot, will be cut selectively. Experimental girdling of undesirable trees will be initiated in some of the less accessible all-aged northern hardwood stands. The compilation and results of the portable chute versus the team yarding study will be worked up during 1937.

A series of permanent plots will be established on the Green Mountain National Forest to study selective stand improvement cuttings, the products of which will be used for fuel.

Assignment

Victor S. Jensen

BOTANY

Project

Phenological observations of forest vegetation in the Northeast. (Bp).

Working Plans

Plan of work for phenological investigations in the Northeastern United States. P. W. Stickel. January 15, 1932.

Instructions for Making Phenological Observations. P. W. Stickel. March 11, 1935. Revised February 28, 1936.

Scope

To obtain observations on the leafing, flowering, and fruiting habits of forest trees, shrubs, and herbaceous vegetation throughout the region, and to correlate such observations with climatic conditions and other natural phenomena such as forest fires, rise and fall of insect activities, increase or decimation of wildlife populations, fruiting and spread of fungi, et cetera.

Status

(a) Since 1930, when this project was initiated, 40 individuals and institutions and 60 Civilian Conservation Corps camps have taken observations of the leafing, flowering, and fruiting of selected forest vegetation. Until 1934 there was a maximum of only 21 cooperators during any one year. The cooperation of the C. C. C. camp personnel has increased the annual number of cooperators to about 80.

(b) Fairly complete meteorological records are being obtained at the Gale River and Bartlett Experimental Forests and the Cherry

Mountain experimental area on the White Mountain National Forest, the Hopkins Memorial Experimental Forest at Williamstown, Massachusetts, and the Chenango Experimental Forest at Norwich, New York.

Progress During 1936

In addition to the regular seasonal observations, a second annual report on prospective seed crops of various forest trees was issued late in the summer, based on questionnaires sent out to all cooperative observers.

Plans for Fiscal Year 1938

Cooperation will be solicited as usual.

Modification of the annual report on prospective seed crops is contemplated for the coming season.

Phenological and meteorological records will be obtained at each experimental forest maintained by the Station.

Every effort will be made to compile region-wide data on periodicity of seed years of important forest trees and upon the effects of unusual climatic factors, such as ice storms, severe winters, drought, et cetera.

Data on flowering habits are being obtained in connection with the Genetics project.

Publications and Reports

Morey, H. F. Prospective seed crops of forest trees in the Northeast, 1936. Northeastern Forest Experiment Station. Mimeographed, 22 pages.

Assignment

H. F. Morey, with cooperation of interested agencies throughout New York and New England.

MANAGEMENT

Project

Management of central hardwoods (M-2).

Working Plans

Plan of work for management of central hardwoods. M. Westveld. January 26, 1932.

Scope

To determine the best methods of cutting central hardwoods and to develop effective silvicultural measures to improve the quality and growth of existing hardwood stands of varying composition and age. Studies included are: (1) methods of cutting and cultural practices, such as weeding, girdling, and thinning; and (2) establishment and development of reproduction following different methods of treatment.

Status

Permanent sample plots established at various periods in the past, many of them dating back to 1905, form the basis of this study. Of a total of 52 plots, aggregating 26.37 acres, 14 consist of two series established near Farmington and Windham, Connecticut, in 1906, to study the development of coppice stands following thinning. Another series of 5, located at Simsbury, Connecticut, was established in 1924 by the Station to study the immediate and future effects of fire in a 20-year-old sprout hardwood stand, and the effect of thinning in such stands. Two additional sets of 23 plots at North Andover and Dover, Massachusetts, comprise the remainder. These were originally

established by the Bureau of Entomology in 1913 to determine how to develop stands resistant to the gypsy and browntail moths through forest management.

Progress During 1936

No plots under this project are due for remeasurement until 1938. Consideration was given to possible sites for the establishment of an experimental forest in the oak region.

Results

None of the data for the plots have been analyzed.

Plans for Fiscal Year 1937

Further surveys of sites suitable for an experimental forest will be undertaken in the course of the year. Routine office work will be continued.

Assignment

M. Westveld and H. F. Morey

MANAGEMENT

Project

Growth, development, and management of northern pines and hemlock. (M-3)

Working Plans

Plan of work: Growth, development, and management of northern pines and hemlock. V. S. Jensen. January 20, 1932.

Working plan, pruning, and girdling operation, Bartlett Experimental Forest. F. E. Cunningham. January 26, 1934.

Scope

To determine the growth, development, and best methods of management of planted and natural grown northern pines and hemlock in both pure and mixed stands.

Status

Sixty-three plots, totaling 28.17 acres, are under observation in this project. These plots, many of which were established by the Forest Service as early as 1905, are summarized by States in the following tabulation:

State	Number of Plots	Area of Plots (Acres)
Connecticut	10	3.75
Maine	2	2.25
Massachusetts	21	11.65
New Hampshire	30	10.52
	63	28.17

In addition to the above, 24 F-1 pine plantation plots at Warner, and New Durham, New Hampshire, have reached that stage of

development which necessitates silvicultural treatment, and will thus contribute toward this project.

The various phases of the project include (1) development and restocking of white pine subsequent to selective logging and clear-cutting; (2) development of planted and natural pine under hemlock and hardwoods, and in old fields; (3) release cuttings of pine; (4) pruning pine stands; (5) thinning pine stands.

Acquisition of the Massabesic Experimental Forest at Alfred, Maine, provides an excellent opportunity for expanding this project into a major activity.

Progress During 1936

No field work was done on the sample plots in 1936. The data obtained from the 1935 and previous remeasurements were computed and analysis of these computations was commenced.

On the Massabesic Forest experimental treatment of a compartment aggregating 124 acres primarily for the purpose of developing resistance to gypsy moth was undertaken. The stand was a variable mixture of pine, oak, red maple, and gray birch. Reduction of the proportion of favored food foliage was handled as a measure of stand improvement, releasing many crowded or overtopped white pines and providing favorable growing space for the better formed oak and maple stems.

Plans for Fiscal Year 1938

Detailed analysis and progress reports will be made on all sample plots established in 1930 or before. A program of experimental pruning,

thinning, and stand improvement will be worked out for the Massabesic Forest after inventory work is completed.

Assignment

H. F. Morey and Jack Zimmerman

MENSURATION

Project

Development of Universal Taper and Volume Tables. (MS-1)

Working Plans

Revised work plan; development of universal taper and volume tables. C. H. Behre. January 16, 1932.

Scope

To study the characteristic stem form of various species in order to develop the possibilities of improving and simplifying the technique of estimating contents of standing trees by the use of universal or general taper curves and volume tables. Attention has been given to the following lines:

1. Conformity of various species to a form equation.
2. Improvement of technique for preparing volume tables by the form class taper curve method.
3. Fundamental principles of tree growth.
4. Factors affecting average form of stands.
5. Factors affecting butt swell and bark thickness.
6. Comparative form of species in mixture.
7. Change in form of residual trees after logging.
8. Application of universal taper and volume tables to certain species.

Status

Results under Objectives 1, 2, and 7 were published in 1927, and under Objectives 4, 5, and 6 in 1935. Observation of trees being studied under Objective 3 will be continued periodically.

Progress During 1936

None.

Plans for Fiscal Year 1938

Preparation of Progress Report on Objective 3.

Assignment

C. Edward Behre

MENSURATION

Project

Growth and yield of spruce and balsam fir. (ME-2)

Working Plans

Plan of work for growth and yield of spruce and fir. C. E. Behre. February 12, 1932.

Procedure for study of growth in Coos County, New Hampshire, and Essex County, Vermont. L. H. Reineke. August 11, 1936.

Scope

To determine the rate of growth and total productivity of the several spruce and balsam fir types in the Northeast; to provide basic information for preparation of plans for managing such stands for continuous, maximum production.

Status

United States Department of Agriculture Technical Bulletin 142 was published in 1929, giving tables of yield for fully stocked, even-aged, second growth stands of spruce and fir. A check on these tables will be furnished by 21 permanent sample plots in New Hampshire and Vermont. These same plots will give badly needed information on the natural loss of trees in growing stands, on changes in composition, and on the tendency of understocked stands to approach a more fully stocked condition because of more rapid growth or minimized losses.

Progress During 1936

Ninety temporary plots were established in Coos County, New Hampshire, and Essex County, Vermont, and increment borings made on

some 3,500 trees on those plots. The plot tallies have been worked up, and all increment cores have been counted and measured prior to analyzing growth rates with respect to species, type, age, site, and density of stocking. This work was undertaken to supply growth data in connection with the preparation of management plans for the Forest Products Cooperative Association, Incorporated, by Region 7. The borings will also be used along with data from other sources for the derivation of region-wide growth rate figures.

Plans for Fiscal Year 1938

Complete the analysis of the Coos County data, assemble additional growth data for other sections of the region, and establish additional temporary and permanent plots in uneven-aged stands and hardwood mixtures as suitable areas are located and resources permit. Five plots in Vermont will be remeasured.

Assignment

L. H. Reineke and M. Westveld

PROTECTION

Project

Ecological effects of forest fires. (Pf-3)

Working Plans

A working outline for study of the influence of forest fire upon standing timber regeneration and site. P. W. Stickel. January 26, 1933.

Outline for working plan for study of basal wounding of standing timber and reproduction by fire. Memorandum to be added to working plan, Pf-3(I-3). P. W. Stickel. July 6, 1933. Memorandum September 22, 1933.

A working plan for the study of the bark character of trees in relation to their resistance to fire injury. P. W. Stickel. December 19, 1933.

Scope

To study the influence of forest fires upon standing timber, reproduction, and soil for the purpose of standardizing methods of appraising forest fire damage, and for the purpose of furnishing basic information pertinent to the reforestation and management of fire damaged areas.

Status

At present this project is confined to investigating:

(a) The effects of basal wounding of trees by fire. For the purpose a series of permanent and semi-permanent sample plots have been established in fresh burns as follows: 1933, 6 plots in New York, equally distributed in number between oak and red spruce cover types; 1934, 1 plot on a control burn of 12 acres in the Bartlett Experimental Forest; and 1935, 10 plots in the oak cover type in

Connecticut. On these plots complete inventories of all dead and live trees at the time of plot establishment have been obtained. All living fire-injured trees were tagged on the permanent plots, and for each of these trees the outlined area of discolored bark has been transferred to special forms. All the plots have been examined annually to follow mortality and other effects of fire injury. As trees die on the permanent plots, the discolored bark is removed and the area of cambial killing is outlined and superimposed on the original bark discoloration diagram.

(b) The relationship between bark character and heat resistance of trees. In this study two types of laboratory work have been undertaken, namely, the determination of bark moisture content of samples taken at monthly intervals from a series of two trees of each of the following species: beech, chestnut oak, sugar maple, eastern hemlock, balsam fir, and pitch pine; and a histological investigation of the bark of the above species. In the field special bark thickness measurements such as total, live, and dead bark thickness, width of fissures, et cetera, were taken on freshly cut stumps of the species in question.

Results

(a) The annual examinations of the plots show that mortality and deterioration are extensive in stands which have been subjected to surface fires which do not kill all the trees outright. Initial mortality is confined to the smaller-sized trees, and on the hardwood plots it has been found that outright killing due to basal wounding varies from 37 to 71 percent of the total number of trees on the area.

Delayed mortality reaches its peak by the second growing season after a fire has run through a stand. However, trees are still found to be dying on the plots which are three years old, where the number of trees originally recorded as alive have been reduced 60 percent in some of the oak plots. The fire injured trees are also heavily attacked by bark and wood boring insects and fungi. Insect attack usually begins a few months after the fire and runs its course during the subsequent year. While the bark and wood boring insects do not bring about the death of the trees attacked, they do cause a material reduction in the quality of the butt log. Positive evidence of attack by fungi is usually seldom seen until during the second to third year after the fire when fungal sporophores appear in abundance within the areas of discolored bark or on the fire scars which have developed. On the average, about 40 percent of the living basal scarred trees become infected with fungi, causing serious sap rot. Also, more than 25 percent of the scorched trees develop open fire scars which heal over very slowly. The extent of scorching is an excellent indication of actual cambial wounding. The removal of all badly scorched trees as soon after fire as possible appears to be a desirable silvicultural practice.

(b) In the study of bark character and heat resistance the investigations dealing with bark moisture content and anatomical structure have been completed. Bark tissues contain relatively large amounts of water during all seasons of the year. From empirical knowledge of the heat resistance of the species being studied, it

appears that bark moisture content varies indirectly with heat resistance. Thus, the bark of such relatively low heat resistant species as beech and balsam fir contains approximately 15 percent more water than does the bark of pitch pine and hemlock, which are decidedly more heat resistant. These differences in moisture content are in part a direct reflection of differences in the anatomical structure of the bark tissues. Beech bark, for example, is composed very largely of living cells. Very little dead bark tissue is formed by this species at any time. In other words, the periderm of beech remains persistently superficial. The reverse condition is found in the bark of pitch pine, which is notoriously fire resistant. In the bark of this species new periderm layers are formed almost every year, which in addition to producing alternate layers of true cork cells also cut off considerable amounts of phloem tissues that in time assume a cork-like character. Thus, the thickness of dead bark exceeds that of live bark at an early age. Balsam fir bark closely resembles beech bark in that its layer of dead tissues is always relatively small. However, more than one periderm layer is formed by balsam fir after the tree is about 50 years old. The remaining species--eastern hemlock, sugar maple, and chestnut oak--have a type of bark formation which is similar to that of pitch pine. In none of these species, however, is the proportion of dead to live bark as high as in pitch pine.

Progress During 1936

(a) A reexamination of all the previously established plots was made during 1936. In addition, three new study areas were laid

out in fresh burns in Massachusetts and New York; two of these areas are in the oak type and the remaining one is in the white pine type.

(b) The special bark measurement work was continued during the summer, and these data are now being analyzed.

Plans for Fiscal Year 1938

(a) Major emphasis during 1937 will be directed toward preparation of standards for determination of fire damage. An attempt will be made to appraise damage in terms of forest type, age of timber, and intensity of burn. As a measure of the latter, it is believed the zones of fire danger indicated by the fire-weather charts prepared by the Station may be used. Fire records compiled in the insurance study and damage appraisals in the field will be interpreted in the light of the intensive study of damage on burned plots as a basis for charts, tables, or slide rule devices showing average damage figures for the factors mentioned.

All permanent plots previously established will be reexamined in 1937. If funds permit the establishment of new plots, these will be confined to the oak cover type. On any new plots established an effort will be made to put into practice certain stand improvement measures such as the removal of badly scorched trees, the favoring of best members of sprouting clumps, et cetera, in order to contrast the results on such treated areas with untreated burns.

(b) After completion of the analysis of the bark measurements, laboratory work will be directed to determining the thermal death point of cambium tissue.

Publications and Reports

Stickel, P. W., and Marco, H. F. Forest Fire Damage Studies in the Northeast. III. Relation between fire damage and fungal infection. Journal of Forestry 34(4): 420-424, illustrations.

_____ 1936. "No loss; the trees were only scorched." The Western Nutmeg 7(2): 1-3, illustrations.

Assignment

Paul W. Stickel, in cooperation with the Yale School of Forestry.

PROTECTION

Project

Forest fire behavior. (Pf-2)

Working Plans

Plan of work for study of forest fire behavior. P. H. Stickel. January 15, 1932.

Scope

Two major lines of investigation were included under this project, as follows:

(a) A study of weather and forest fuel moisture relationships in order to determine the various degrees of fire hazard which are produced by different types of forest fire-weather.

(b) Study of the prediction of forest fire-weather so that methods of forecasting the occurrence of dangerous periods of weather can be worked out more accurately and for longer periods than is now possible.

Status

(a) The field work in this phase of the fire behavior study was completed in 1930. Since that date, the data from the fire-weather stations which were maintained from 1925 to 1930 inclusive have been analyzed and the results published as separate papers. A general bulletin on forest fire danger in the Northeast is now in preparation.

(b) In the Northeast two Weather Bureau offices receive special supplementary reports from a network of fire-weather stations. In New England such data are furnished to the Weather Bureau in Boston,

while in New York similar stations report to the Albany office of the Weather Bureau. These data are used in conjunction with the regular and special reports and forecasts of forest fire-weather conditions which are issued from the Albany and Boston offices during the forest fire seasons. Under cooperative agreements such reports and forecasts are furnished to all state and federal forestry agencies in the region. No direct contacts with the Weather Bureau dealing with research aspects of this work have been had during the past year.

Results

(a) The weather-fuel moisture data have shown that duff moisture content is a good index to forest fire hazard and that it can be estimated from integrated measurements of relative humidity, air temperature, and number of hours since last measurable precipitation. Evaporation data, for either short periods or 24-hour intervals, can be used in place of relative humidity and give more accurate estimates. Alinement charts for estimating duff moisture content and degree of hazard from measurements of the above meteorological elements have been prepared for the following cover types: white pine, red spruce-balsam fir at high altitudes and in northern Maine, and mixed red spruce and northern hardwoods. It is believed that these charts which translate fuel moisture readings into zones of hazard adequately meet the needs of the protective organizations.

Plans for Fiscal Year 1938

(a) The general report on forest fire danger will be completed during 1937.

(b) The regular forecast and warning service of the past will be continued by the Weather Bureau.

Assignment

(a) Paul W. Stickel.

(b) United States Weather Bureau, Boston Office, in cooperation with the State Foresters of New England and the White and Green Mountain National Forests.

PROTECTION

Project

Forest fire attack. (Pf-1)

Working Plan

Plan of work for study of forest fire attack. P. W. Stickel. January 15, 1932.

Scope

The study of forest fire attack, which is largely an administrative function, comprises the following three phases:

(a) Prevention, which is characterized by the analysis of forest fire statistics for the dual purpose of obtaining accurate information regarding forest fire hazard, risk, and damage in different parts of the Northeast and of providing a basis for fire control planning.

(b) Control, which is concerned with testing the efficiency of new materials and equipment under actual burning conditions.

(c) Detection, which has to do with the analysis of forest fire lookout systems by mapping seen areas visible from all potential lookout points and thus furnishes the basic data necessary for the final selection of lookout locations which will give the greatest degree of coverage with the minimum number of lookout towers.

Status

(a) In cooperation with state forestry departments, reports on the analyses of fire records of New Hampshire (1921-1925) and Maine (1916-1925) have been published. Analyses of Vermont fires for the

period 1911-1915 and of Connecticut fires for 1921-1925 have also been made. Nothing is being done along this line at present.

(b) Several years ago two materials to aid in fire control were tried out on grass fires, namely, commercial calcium chloride and Zenith Fire Dust. Calcium chloride was found to have a limited value under proper weather conditions by reason of its effect in increasing the moisture content of materials to which it is applied and thus retarding the spread of fire. Zenith Fire Dust was found wholly ineffective either in retarding or extinguishing fires. Nothing is being done in this field at present.

(c) Visibility analysis on the White Mountain Forest was undertaken late in the fall of 1936.

Progress During 1936

At the request of the White Mountain National Forest a cooperative study is being made of the lookout system on that Forest. Plans have also been made, at the request of the Division of Clarke-McNary Cooperation in Region 7, to assist the Rhode Island Division of Forests, Parks, and Parkways in making an analysis of the detection system in that State. The Station has assumed responsibility for getting the work under way and analyzing the final data, but the actual plotting work is being done at one of the Rhode Island Civilian Conservation Corps Camps.

Plans for Fiscal Year 1938

Visibility for all potential lookout points on the White Mountain National Forest will be studied in relation to data on fire occurrence,

hazardous slash areas, concentration of population, et cetera, as a basis for final selection of lookout points which will be made in collaboration with the administration organization. Sufficient supervision will be given to the detection study in Rhode Island to push that study to completion as rapidly as possible.

The Station will employ an experienced man during the summer of 1937 to study economic phases of fire control planning for the White Mountain National Forest. It is hoped that a report may be compiled which will serve as a basis for sound administrative decisions on such matters as the intensity of fire prevention activities and extent of fire detection facilities in relation to fire danger, resources at stake, recreational and scenic values, and opportunity for public education.

Assignment

Paul W. Stickel and Robert C. Dustin.

PROTECTION

Project

Rots in balsam fir pulpwood timber (Pd-7).

Scope

To determine the progress of decay in standing pulpwood timber as the basis for management, to utilize all the balsam fir which the land produced, and to avoid the usual waste from windfall and decay.

Status

Under the usual methods of operation in the spruce and fir forests of the Northeast all merchantable softwoods are removed. This leaves so little advance growth that a period of at least 50 or 60 years must elapse before another cut can be made on the same area, but before the end of this period much advance growth of balsam has grown to merchantable size, becomes infected with decay, and blown down by the wind.

Silvical study is now being given to the possibility of a system of partial cutting which will permit successive cuts on the same area at intervals of from 25 to 35 years, in the hope that most of the waste will be thus avoided. Concurrent pathological studies to determine relative frequence of various fungi, methods of infection, rate of spread, and conditions under which trees are most subject to infection are under way.

Sometime before 1924, studies of this sort were begun in Canada. Intensive analyses of rot conditions in two typical balsam stands, supplemented by prolonged cultural study of the rots involved, were made. Similar work was undertaken to determine the progress of decay under conditions found in the northeastern United States.

Results

Three rots have been found to cause most of the loss in balsam fir. Two are butt rots, one brown "charcoal" rot caused by Polyporus balsameus, and a stringy rot caused by Poria subacida. A third rot occurs in the upper and middle trunk, and is commonly known as red heart. It is caused by Stereum sanguinolentum. There were a few scattering cases of infection by some of the common saprophytic wood-rotting fungi and some damage by carpenter ants. The following table gives the relative importance of these agencies at Gale River:

Cull Percentage by Causal Agents

Based on Merchantable Volume, 400 trees

Causal Agent	Cull percent	Percent of Trees Affected
Butt Rots	4.5	41.8
Red Heart	2.9	7.1
Miscellaneous Rots	.2	.5
Ants	.3*	5.0
	7.9	47.9**

*Cull cases produced by ants and butt rot together are included in the butt rot cull percent.

**Twelve trees had both top rot and butt rot in them, and six trees had both ants and butt rot in them.

Decay was found to be correlated with age, but not with diameter or vigor of the trees. On poorer sites the stand is breaking over to a considerable degree from the weakening of the trees by butt rots, indicating the need for early harvesting to prevent rather heavy loss.

Two one-quarter acre plots of mature balsam fir were cut and examined for decay at Newcomb, New York. The three rots found in this species in New Hampshire were found to be causing loss here also. There were but two trees with ants. Several trees were killed by lightning and several by porcupines.

Analysis was made of decay in three localities. One of these was in a 40- to 55-year stand of balsam fir at Indian Town, Maine, and a second was at Cherry Mountain, New Hampshire. In both of these Civilian Conservation Corps labor was supplied for the work. The third locality was the Whitney estate at Sabattis, New York. Here data were obtained from trees in swamp, intermediate upland, and dry slope, giving a series covering the range of conditions on the cutting area. The chief rots found were those previously found at Gale River, New Hampshire.

Progress During 1936

Additional cuttings were made in younger age classes at Indian Town, Maine, and in faster growing stands in Columbia, New Hampshire. It has been found that some of the brown charcoal butt rot may be caused by Polyporus schweinitzii, but it appears not to be feasible to distinguish this rot in the field from that caused by Polyporus balsameus.

Plans for Fiscal Year 1938

It is believed that varied enough data are now available to justify publication. Should it be feasible to get data from Vermont and northern Maine sometime in the future, it will be done for the sake of completeness, but this is not believed to be vitally important.

Assignment

Bureau of Plant Industry, Perley Spaulding, J. R. Hansbrough, and H. G. Enc.

PROTECTION

Project

Nectria and Strumella diseases of hardwoods (Pd-9).

Scope

An investigation of the diseases of hardwoods caused by Nectria and Strumella species, aimed at feasible modifications of usual silvicultural methods to control and reduce the present widely spread and rather heavy damage, especially in younger stands.

Status

Early in the initiation of the Emergency Conservation Work and the establishment of the Civilian Conservation Corps camps the Division of Forest Pathology began work designed to aid in the proposed work of forest improvement along two lines; i. e., first, demonstration and education of camp and group leaders as to certain types of diseases which should be taken into account in the silvicultural work undertaken, and second, investigations of certain such diseases to supplement the knowledge available and enable the forest pathologists to make definite recommendations concerning silvicultural methods of treatment best adapted to the reduction of these diseases.

Dr. J. S. Boyce of Yale and Dr. D. S. Welch of Cornell were engaged for the educational phases of the work, which continued for about a year in the New England camps. The investigative work has been conducted along the following lines:

A. Nectria: Detailed study of condition of individual trees and fruiting of Nectria on as many species as possible under a wide range of environmental conditions, subjecting infected trees to the following treatments.

Lot I. Girdled and left standing.
II. Felled and left lying.
III. Felled and branches severed.
IV. Felled and canker edges peeled for 3 inches.
V. Felled and sectioned with cankers cut out, but let lie.
VI. Inoculations in healthy trees.

B. Strumella: Similar to the Nectria study, but with the following treatments:

Lot I. Girdled and let stand.
II. Felled and let lie (checks).
III. Felled and cankers peeled 3 inches on edges.
IV. Felled and cankers covered with earth, leaves, et cetera.

C. In 1933 one series of Strumella experiments was started in the only location suitable for this work which could be found in this region. However, ample tests of this fungus have been undertaken by other workers farther south.

Nectria experiments have been started and are now well under way in three of the Connecticut State Forests, in the White Mountain National Forest in New Hampshire, and the Green Mountain National Forest in Vermont. The various treatments were applied to a total of 566 trees of the following species: black, white, gray, and yellow birch; red, sugar, and striped maple; aspen; bigtooth aspen; beech; and black oak.

Culture tests of Nectrias collected from various tree species have been in progress since 1933. A serious disease of beech, caused by a bark-piercing insect and a Nectria in the Canadian Provinces of Nova Scotia and New Brunswick, which is extending into Maine and Massachusetts, made it imperative to learn whether the Nectria from one species of tree would attack other species. This is a matter of vital importance in the treatment of forests by the C. C. C. men. Besides this, Nectria cankers in individual trees have been studied in an effort to learn more of the life history of the disease and its methods of attack. In conjunction with the Nectria canker work, a considerable number of field inoculations have been made. Twelve different tree species have been inoculated with cultures obtained from another group of 12 species.

In connection with the Beech-Coccus-Nectria disease, 37 plots of 50 beeches each were established in 1933 in Maine within infected areas, observations upon which are to continue indefinitely. These are designed to prove the sequence of attack by the insect and the Nectria. A Nectria similar to the one generally accompanying the insect has been found in New Hampshire and in Vermont far beyond the known distribution of the insect.

Results

The work has shown that there are a number of different Nectrias occurring on northeastern hardwoods. Some appear to attack many species of trees, while others are restricted in their natural hosts. Some tree species seem to be resistant to the Nectrias while others

are very susceptible. Some species, such as beech, striped and mountain maple, are susceptible to many of the Nectrias and may be sources of infection for the more valuable species.

The size of stem on which infection takes place appears to influence fruiting of Nectria, small twigs and saplings being killed before fruiting occurs. Moisture also appears to play an important role.

The removal of discrimination against cankered trees is desirable in silvicultural work or utilization operations. Where removal is not practical, any treatment which increases the dryness of infected trees and sloughing of bark will be helpful in reducing fruiting activity of the Nectria.

Progress During 1936

Two new series of inoculations have been made to clear up certain questions not adequately answered by our earlier work. A series of permanent plots was established in cooperation with the Vermont State Forester on the Vermont State Forest at Groton, to test the effect of releasing and thinning on the Nectria disease. The experiments must continue for an indefinite time.

Further work has fully confirmed the occurrence of infection of very young shoots by Nectria and the prompt killing of numerous sprouts by such cankers. Thus we find Nectria is a serious enemy of young stands beginning with the young seedlings and sprouts, and continues to attack younger branches of older trees in some species, notably the birches.

Attention has also been drawn to the occurrence of obscurely evident bark-covered cankers, notably on the gray, paper, and yellow birches, and on sugar maple.

It is now thought that Nectria canker is serious only in stands that are below par in vigor. Some of the factors causing such a slowness in growth are: elevation, exposure, poor site, repeated burns, or very hot ones. Because of its prevalence forest managers should give consideration to Nectria infection in determining the objective for use of each area. Timber production may be a secondary consideration in some instances, and other objectives such as game production, watershed protection, recreation, and soil improvement may very properly be given consideration. For such objectives Nectria infection may not be important, and expenditures for reduction of infection should be gauged accordingly.

Plans for Fiscal Year 1936

To carry on lines of work now under way and take up only such new ones as are most urgent and which our reduced force can adequately handle.

Publications and Reports

Grant, T. J. Nectria cankers on Northeastern hardwoods. United States Department of Agriculture (Emergency Conservation Work). Unnumbered circular. 5 pp., mimeographed. May 11, 1936.

Spaulding, Perley. Forest diseases and land use. 5 pp., typed. Read at meeting of New England Section, Society of American Foresters. February 1936.

_____ Nectria canker of hardwoods in New England. Forestry Organizations of New York and New England, Tree Pest Leaflet 10:1-4. Oct. 1936.

Spaulding, Perley, Grant, T. J., and Ayers, T. T. Investigations of Nectria diseases in hardwoods of New England. Journal of Forestry 34: 169-179. February 1936.

_____, Bidwell, C. B., Boyce, J. S., and Gottlieb, A. M. Report of Committee on forest disease control. Society of American Foresters, New England Section. 3 pp., mimeographed. March 1936.

Welch, D. S. The range and importance of Nectria canker on hardwoods in the Northeast. Journal of Forestry 32(9): 997-1002. December 1934.

Assignment

Bureau of Plant Industry, Perley Spaulding; Emergency Conservation Work, T. J. Grant and Mrs. Alice J. Watson.

PROTECTION

Project

Plantation diseases (Pd-10).

Scope

To determine the frequency of diseases occurring in artificial forest plantations, their life histories, their relation to environment, and possible methods of management which will reduce or prevent their outbreak.

Status

For several years attention has been drawn with constantly increasing insistence to disease as a serious factor in the development of plantations which have been predominantly pure stands of single species. Extensive pure stands greatly favor heavy loss from disease, whereas mixed stands of two or more species allow a choice of species to favor in later management if trouble develops with one of them. The large total acreage of such plantations which have been made with steadily increasing rapidity since 1900 has received comparatively slight attention. The plantations of 1900 to about 1920 have reached that stage in their development where they must be cared for or heavy losses will result. The closing of the stands with resulting stagnation already has taken place in the older plantations. Various diseases are greatly favored by such conditions, and are beginning already to take their toll. The great expansion in planting which began about 1920 is making a problem which will be of directly proportional importance and magnitude when these

later plantings reach the critical closing age. It is inevitable that there will be imperative need for study of the diseases which will surely appear and to learn the best methods of dealing with them, and, if possible, prevent serious losses. The earlier this can be gotten under way, the more efficient will be the work of prevention.

The trees that have been or are being planted in large enough numbers in the Northeast to be considered in a study of forest plantation diseases are as follows:

Pinus banksiana, nigra, ponderosa, resinosa, strobus, sylvestris, thunbergii.
Picea excelsa, glauca, rubra.
Larix dahurica, europea, leptolepis.
Pseudotsuga taxifolia.
Abies balsamea.
Thuja occidentalis.
Tsuga canadensis.
Robinia pseudoacacia.
Fraxinus americana.
Quercus borealis.
Prunus serotina.
Acer saccharum.

There is a definite trend toward the use of hardwoods, the number of which will quite certainly increase as the proper methods of producing stock become known.

Results

Several investigations of plantation diseases have been carried on in the last few years under projects Pd-5, shade and ornamental tree diseases, and Pd-6, miscellaneous forest tree diseases.

A threatening canker of Pinus resinosa caused by Tympanis sp. broke out in plantations near New Haven, Connecticut. It has been studied intensively, and the fungus has been found to be a weak

parasite of red pine which causes disease when the host is weakened by environmental factors, such as drought, suppression, and possibly planting south of its natural range.

In 1928 large blocks of European larch trees, in which the true larch canker, Dasyscypha willkommii was present, were destroyed by the owners. Scouting for the disease continued without additional infections being discovered. In 1935 it was discovered that cankers were present on trees which previously had been free of them. Immediately intensive and very careful scouting was begun. All suspicious specimens have been critically examined in the laboratory and cultured if necessary. On the Mathews estate in Hamilton, Massachusetts, the disease has been found in trees adjacent to those removed in 1928. All of these trees have been destroyed. Scouting of the surrounding country has resulted in locating eight additional cankered trees on an estate adjacent to the Mathews place. One of these is a new host for the disease, namely, golden larch, Pseudolarix kaempferi. The evidence indicates that in the 20 years that the disease was undiscovered and undisturbed it had attained a momentum such that it was on the point of becoming a serious outbreak. The infections found lately appear to be recent ones. Their distribution is disquieting as it indicates an aggressiveness which is new to us.

A canker of various pines associated with the fungus Atropellis sp. has been under investigation. In New England it occurred in plantations of Pinus resinosa and Pinus sylvestris. It is present on numerous species of pines well over the country. A manuscript is in preparation.

Leaf blight of Abies concolor caused by Rehmiellopsis bohemica, and of Douglas fir caused by Rhabdocline pseudotsugae, has been known in plantations of eastern Massachusetts for several years. The former has also been found on native Abies balsamea in Ontario and northern Maine, and it is known on Abies from Rhode Island and New York. Its origin may be Europe, where it is known to occur. The latter is apparently native on Douglas fir in the Northwest, but is not yet generally distributed in the Northeast.

Progress During 1936

Spraying experiments were carried on with the leaf blight of Abies concolor caused by Rehmiellopsis bohemica and of Pseudotsuga caused by Rhabdocline pseudotsugae, with very encouraging results.

A severe cankering of Picea excelsa 21 to 23 years old, planted 6 x 6 feet, at Petersham, Massachusetts, was called to our attention. Isolations in culture indicate that the fungus concerned is Valsa sp. Since the Harvard Forest is initiating pruning and thinning work in those plantations, it seemed an opportune time to lay out a series of plots for disease experiments designed to show the effect of fertilization, pruning, and thinning. The crowded condition of the trees appears to be primarily responsible for the trouble. Forty-two plots were established for this purpose.

During the scouting for European larch canker a small, definitely limited canker was found on Larix leptolepis. It is associated with the fungus Phomopsis sp. and is entirely different from the Dasyscypha willkommii canker.

A canker of Pinus strobus in this country caused by Phomopsis strobi, and a canker of a number of conifers in Europe caused by Phomopsis sp., have been known for a number of years. It is now believed that the American and European fungi are identical. If this is so, we are liable to encounter it on numerous conifers from the Atlantic to the Pacific Ocean. How important it may be is largely unknown.

Plans for Fiscal Year 1938

Index important older plantations of New York and New England, including the following points so far as feasible: species, location, owner, number of trees or area of plantation, nursery where grown, spacing of planting, age and type of stock, source of seed, method of planting, pure stand or mixture, soil character, soil acidity, slope, aspect, vegetation of planting site, site index, planting mortality, diseases noted, by whom, amount of infection, number of years present, damage, possible method of control.

Examine plantations for diseases and investigate new troubles, to the extent that such work can be fitted in with other projects.

Publications and Reports

Diller, J. S. The Atropellis canker of eastern pines. United States Department of Agriculture, Plant Disease Reporter 19:17. February 15, 1935; Pennsylvania Department of Forests and Waters, Service Letter, Series 5(46): 2-3. November 15, 1935.

_____ A new canker of Pinus associated with Atropellis sp. Manuscript.

Hahn, G. G., and Ayers, T. T. The European larch canker and its relation to certain other cankers of conifers in the United States. Journal of Forestry 34: 898-908. October 1936.

Hansbrough, J. R. A new canker disease of red pine, caused by Tympanis pinastri. Science, N. S. 81: 408. April 26, 1935, also Forestry Chronicle 12: 142-143. June 1936.

_____ The Tympanis canker of red pine. Yale University School of Forestry, Bulletin 43: 1-58. 1936.

Miller, J. A., and Aldrich, K. A. Pseudolarix amabilis, a new host for Dasyscypha willkommii. Science, n.s. 83: 499. May 22, 1936.

Spaulding, Perley, Bidwell, C. B., Boyce, J. S., and Gottlieb, A. W. Report of Committee on Forest Disease Control. Society of American Foresters, New England Section. 3 pp., mimeographed. March 1936.

Assignment

Bureau of Plant Industry, Perley Spaulding and J. R. Hansbrough.

PROTECTION

Project

Heart rots of hardwoods (Pd-8).

Scope

To determine the frequency and symptoms of heart rots in hardwoods, the significance of injuries leading to their entry, losses caused, relation of loss to external symptoms, and methods of management which will reduce their occurrence.

Status

At various times since 1931, examination has been made of living northern hardwood trees by felling and dissecting for decay. Such examinations have been made at Gale River, Bartlett, and in mill logs at Easton and North Stratford, New Hampshire, and at Peru, Vermont. Observations in fellings of various sorts are made as opportunity occurs. A set of rules for estimating cull in northern hardwoods has been formulated and circulated for general use.

Preliminary investigation of the occurrence of decay in coppice oak stands has been followed up by intensive study of trees cut from 4 one-quarter acre plots in cooperation with the Connecticut State Forestry Department. On these plots amount of decay, organism causing decay, and transmission of decay from parent stump to sprouts, and from sprout to sprout, were determined.

A new disease (Polyporus hispidus), causing rot in oaks, has been studied in Connecticut. The fruits of this disease form late in the fall and soon disappear, so that its work is easily confused with

Strumella cankers.

Progress During 1936

During the past few years extensive cultural work with the rots of various trees has been carried on in the central office in Washington, D. C. It is becoming evident from this work that several unsuspected fungi are causing important rots in oaks, also that checking the rots in cultures is an important part of the identification of rots in field studies.

Studies of decay in coppice lead to the following conclusions: Seedlings or seedling sprouts should be favored. Sprouts from small stumps should be favored over those from large stumps. Single sprouts are preferable to fused sprouts. Sprouts originating low on the stump should be favored over those of higher origin. Fused sprouts 3 inches or under in diameter should be cut flush to facilitate early healing. Fused larger sprouts should either all be cut or none, and should be avoided as crop trees.

Plans for Fiscal Year 1938

Continue along same lines.

Publications and Reports

Campbell, W. A., and Davidson, R. W. New heart rotting fungi occurring in species of hardwoods, especially oaks. Manuscript for publication.

Davidson, R. W., Campbell, W. A., and Blaisdell, D. J. Cultural identification as a necessary supplement to tree decay studies. American Phytopathology Society, Abstracts of Papers to be presented at the twenty-eighth meeting, December 28 to 31, 1936. 18 pp. December 1936.

Roth, E. R., and Sleeth, Bailey. Decay in sprout oak stands. United States Department of Agriculture, Bureau of Plant Industry, unnumbered circular. 4 pp., mimeographed. September 9, 1936.

Sleeth, Bailey, and Bidwell, Bradford. Recommendations for keeping the decay hazard at a minimum in silvicultural cuttings in Connecticut sprout hardwood stands. Connecticut Forestry Department Circular 3: 1-4. July 15, 1936. Mimeographed.

Assignment

Bureau of Plant Industry, Perley Spaulding, J. R. Hansbrough, H. G. Eno, and T. J. Grant (Emergency Conservation Work).

PROTECTION

Project

Chestnut blight (Pd-1).

Scope

To study the feasibility of replacing native with resistant species or hybrids, or by development of resistant races of the native species.

Status

Because of attacks of a native fungus on the oriental chestnuts set in the field, it may be that our greatest hope lies in the finding of resistant native trees or the breeding of resistant new varieties.

Results

The public is calling attention with increasing frequency to resistant native trees which are producing nuts. The most promising are being examined. Experimental plantings of oriental chestnut were made in the Northeast from 1930 to 1932, as follows:

Connecticut	6,800
Rhode Island	1,000
Massachusetts	1,625
New Hampshire	5,000
New York	18,628
	33,053

The oriental chestnuts appear to be hardy, but some were broken down by heavy masses of drifted snow. A native fungus is attacking

them and killing twigs and leaders so that the outlook for the future is not hopeful.

The Division of Forest Pathology is examining the plantations of oriental chestnuts carefully each year and noting their reaction to climate, fungi, insects, et cetera. A study of the native fungus which is attacking them is being carried on.

Cooperative breeding experiments, which have been under way for several years, are being continued.

Plans for Fiscal Year 1938

To continue as at present.

Publications and Reports

√ Graves, A. H. Chestnut breeding work in 1935. Brooklyn Botanic Garden Record. 25: 62-75. April 1936.

Assignment

Bureau of Plant Industry, Perley Spaulding and J. R. Hansbrough.

PROTECTION

Project

White pine blister rust (Pd-2).

Scope

Investigation of the disease for new developments in habits or character.

Status

Past investigations are published. Use of resistant species is advocated for critical areas or conditions.

Results

Experimental plantings of Pinus peuce have been made as follows:

Maine:

Bingham; S. D. Warren Company nursery in 1933 had 3,000 5-year transplants which were thrifty and would average 6 to 8 inches tall. We understand that in the spring of 1934 all but 1,000 of these were planted in neighboring localities within a few miles of the nursery. One thousand were bought by us and distributed for planting at the following five places in lots of 200 each:

Gale River Experimental Forest, Bethlehem, New Hampshire
Yale Forest, Keene, New Hampshire
New York State experimental area, near Schenectady, New York
Chenango Experimental Forest, near Norwich, New York
New Haven Water Company land, in North Branford, Connecticut

New Hampshire:

Keene, Yale Forest; 1932 - 100, 1934 - 200, 2-3 transplants.

Bethlehem, Gale River Experimental Forest; 1932 - 300, 1934 - 200.

Charlestown, State Forest Service; 1931 - 300-400.

These trees were inspected in September 1934. They were growing in an old pasture area heavily grown up with brakes, weeds, and berry bushes. They varied in height from 1 to 4½ feet. They had done as well as Pinus strobus would do under the same conditions.

Gerrish, State Forest Service; 1938; several 2-year-old seedbeds very uniform in germination. Pinus strobus of same age had made a secondary late seasonal growth of 1 to 2 inches, but the Pinus peuce did not. Aside from this, the two were identical in size and apparent vigor. This late season growth habit may account for the difference of relative growth of Pinus strobus as contrasted with Pinus peuce.

Vermont:

Groton State Forest; 1929 - 2100. These were planted in furrows in an old field heavily grown up to goldenrod in dense masses over most of the area. Personal examination resulted in finding but a very few alive, and these were so badly overshadowed that it is doubtful if they can survive long. Pinus strobus would have done no better.

Massachusetts: Pelham, C. Edward Behre; 1932 - 1100.

Connecticut: Eli Whitney Forest, New Haven Water Company, North Branford.

New York: Chenango Experimental Forest, Norwich, New York; 1934 - 200.

New York State Experimental Area, Schenectady, New York; 1934 - 200.

Ohio: Wooster, State Forester; 1918 - 20. In 1932 these averaged 13.6 feet high.

Oregon: Mount Hood, United States Division of Forest Pathology; 1931 - 700. A study of secondary fungi of blister rust cankers is under way.

The supposed immunity of Pinus peuce has been placed in doubt; indeed, the evidence even makes its decided resistance doubtful. Tubeuf, in a personal letter, states that in Europe trees of pole size (15 to 20 years?) with many side branches are entirely healthy, but seedlings in the same vicinity, 4 years old, have become heavily infected and are dying. Moreover, we found a single 2-3 year transplant at Bingham, Maine, which in our opinion certainly had died from the blister rust.

Rigid tests by the Division of Forest Pathology prove that there is a really immune variety of cultivated red currant derived from the so-called "Norwegian Red." Because of uncertainty of descriptions of this ancient variety, this has been named "Viking" with a careful description. The use of such an immune cultivated currant is exceedingly difficult, if not impossible, in areas where cultivated Ribes are banned.

Plans for Fiscal Year 1938

Routine studies only.

Publications and Reports

Hahn, G. G. Immunity of Viking red currant from white pine blister rust under field conditions. Phytopathology 26: 860-875. September 1936.

Assignment

Bureau of Plant Industry, Perley Spaulding, J. R. Hansbrough, and G. G. Hahn.

PROTECTION

Project

Shade and ornamental tree diseases (Pd-5).

Scope

To answer inquiries on this subject.

Status

Entirely incidental and limited to local cases. A few cases require handling each year.

Results

Discovery of European larch canker. Investigation of willow scab with discovery of resistant willows. In the winter of 1931-1932 much winter injury of various ornamentals occurred. The junipers and related species were especially damaged. Considerable damage to sugar maple shade trees has been noted as caused by the fungus Volvaria bombycina. Consultation with Massachusetts State representative on treatment of trees on Willard Brood State Park. Advice on removal of dwarf mistletoe in white spruce on the grounds of Hotel Champlain, Plattsburg, New York.

Nectria cinnabarina has been noted attacking European beech and Japanese maple in an aggressive parasitic manner. Verticillium has killed a Norway maple, 10 inches diameter breast high and with no competition from other trees, within one year.

Progress During 1936

For a considerable number of years twig and needle blight of various pines caused by Sphaeropsis ellisii (Diplodia pinea,

Botryodiplodia pinea) has been known in Europe and numerous localities in the United States. Recently the same fungus has been reported as attacking Douglas fir in New Zealand and earlier in Italy. Unfavorable soil conditions seem to have brought on the trouble with Douglas fir. The fungus may have spread to it from infected pines nearby. During the last two years it has been found in the United States, attacking Douglas fir where it appeared to have spread from diseased pines.

Plans for Fiscal Year 1938

Routine examination of specimens submitted, and answer to inquiries.

Publications and Reports

√ Waterman, A. M., and Miller, J. A. A die-back of Douglas fir. Phytopathology 26: 804-805. August 1936.

Assignment

Bureau of Plant Industry, Perley Spaulding and J. R. Hansbrough.

PROTECTION

Project

Miscellaneous forest tree diseases (Pd-6).

Scope

It includes work upon forest tree diseases not covered by other projects.

Status

Work has to be done upon newly noted forest diseases and specimens which are sent in for diagnosis which are not covered by our other projects. Oftentimes considerable work must be given to a disease before it can be determined whether it should receive more intensive and prolonged study. Again, numerous instances occur where a disease is of such a character that prolonged investigation is not urgent or where tentative recommendations concerning methods of control can be made. Such cases can be handled only under a project of general nature, such as miscellaneous forest tree diseases.

Results

A collection of specimens of tree diseases is arranged for exhibit in the office, and many are collected and filed for reference. Literature on the tree diseases of the Northeast is indexed.

Resinosis of red and white pines in New York plantations and similar trouble in Maryland has come to our attention. Investigation is under way by other agencies. A similar trouble of Douglas fir reproduction is known in Colorado. The cause is unknown.

The investigation of the Dasyscypha diseases of conifers is largely completed and in process of publication by the Division of Forest Pathology.

The Woodgate rust of Scotch pine has been reported from widely separated points in the provinces of Ontario, Quebec, and Nova Scotia. It is still questionable whether this is not a western rust which was brought east some years ago in infected young trees. It appears to be more widely distributed than was supposed at first. Experimental work by the New York Conservation Department, in cooperation with the Division of Forest Pathology, has proved it to be communicated from tree to tree without an alternate host.

A serious leaf-cast disease in nursery seedbeds and transplant beds has been causing extensive damage. It attacked Pinus resinosa especially, although it appeared to some extent on Pinus strobus. Spraying with Bordeaux mixture or lime sulphur has been found to control this trouble in Europe. See Technical Note 18.

A puzzling dying of beech of all ages in the western Adirondack region appears to be caused by adverse climatic conditions. Drought and winter injury are believed to have caused it. See Technical Note No. 20.

Serious infection of large pruning wounds on young Pinus strobus in plantations has occurred. It is caused by Stereum sanguinolentum. This unexpected development with this fungus has very serious aspects which were called to public attention in Technical Note No. 19.

Progress During 1936

A die-back of twigs of young oak in central Massachusetts has been known for a number of years. It occurs especially on red oak, but to some extent on other oaks also. It kills the new growth of terminal shoots of the main stem and lateral branches so that growth is delayed and the affected shoots are crooked. A cooperative investigation with the Entomologist has shown that late spring frost was the cause of the trouble.

Observations and collections show that the hemlock cone, twig, and leaf rusts are much more generally distributed than has been suspected. This is true of a number of other forest tree diseases which have been considered local, uncommon, or rare. A knowledge of special habitat, season of fruiting, and relation to weather results in most unexpected finds. The ecology of the fungi is a great aid in advancing our knowledge of their relations to the trees.

About 250 surplus specimens were exchanged with the University of Toronto for an equal number of eastern Canadian fungi, which are of value to us for data on hosts and northern distribution. A valuable and cordial contact was established, which is proving an aid in the determination of fungi not known to us.

A policy has been tentatively initiated of making reconnaissance collecting trips occasionally. Such procedure is proving valuable in adding to our knowledge of forests and diseases in areas which otherwise would be unknown to us.

The root and butt rot of conifers caused by Polyporus schweinitzii has been under study in culture and considerable variation

noted. A manuscript is prepared for publication.

A peculiar water-soaked appearance within wood of living trees of Populus, Salix, Ulmus, Abies, Tsuga, Prunus, Morus, Prosopis, Platanus, Quercus, and Elaegnus has been noted. Bacteria appear to be associated with it. The so-called "wetwood" is common in Abies balsamea. What its significance may be is still uncertain.

An investigation was made at Rochester, Massachusetts, of root rot of white pine. It appears to be caused by Fomes annosus. According to accounts of land owners, it really is caused by stagnation in thick stands at about 35 years of age. It is extensive in that section where the soil is a sterile sand and white pine reproduces abundantly. Conditions are much like those in closely grown plantations where stagnation and resulting deterioration take place.

The Dutch elm disease work has continued along established lines. Destruction of diseased trees has kept well abreast of their discovery. The disease has been found in Connecticut at points between the large area of infection around New York City and Old Lyme, where the easternmost affected trees have been found. The attitude of those in charge of the work is more optimistic than hitherto. Poisoning of diseased trees without felling seems to offer a cheaper and, it is believed, an efficient method of dealing with them. Many roadside elms that were in poor condition have been removed in southern New England. Considerable cutting out of dead branches and pruning have also been done, all of which should help to reduce the hazard of infection.

Plans for Fiscal Year 1938

Continue as at present.

Publications and Reports

Spaulding, Perley, and Childs, T. W. Variability of Polyporus schweinitzii in culture. Manuscript for publication.

_____, Bidwell, C. B., Boyce, J. S., and Gottlieb, A. W. Report of Committee on Forest Disease Control. Society of American Foresters, New England Section. 3 pp., mimeographed. March 1936.

Crandall, B. S., Hartley, Carl, and Davidson, R. W. Wetwood. American Phytopathology Society, Abstracts of papers to be presented at the twenty-eighth meeting, December 28 to 31, 1936. 18 pp. December 1936.

Assignment

Bureau of Plant Industry, Perley Spaulding, J. R. Hansbrough, and H. G. Eno.

PROTECTION

Project

Dendroctonus piceaperda Hopk.

Scope

To establish sample plots in the Green Mountain National Forest and make observations to determine if the insect is increasing in the overmature spruce stands and whether or not control measures are feasible or necessary. Also to determine the important natural factors in the control of this pest.

Status

An area, estimated at from 700 to 900 acres, of overmature spruce, dead and dying from attacks by this bark beetle, has been located in the Falls Brook drainage on the Green Mountain National Forest near Rochester, Vermont. Several small infestations have subsequently been found in other parts of the forest.

Plans for Fiscal Year 1938

Observations will be continued.

If possible, some experiments in tree medication will be carried on here.

Assignment

J. V. Schaffner, Jr., Bureau of Entomology and Plant Quarantine.

PROTECTION

Project

Miscellaneous forest and shade tree insects.

Scope

To make incidental observations on the life histories and habits of miscellaneous forest and shade tree insects that are of economic importance and to carry on experiments on their control. To answer inquiries and to advise on the proper control measures that should be used.

Status

Ellopia athasaria Gn. - In September, 1934, this looper caused serious defoliation of hemlock over an area of approximately 12 acres near Erving, Massachusetts. Sixty trees were numbered for observation on their recovery. The defoliation of the individual trees in 1934 ranged from 70 percent to 100 percent, and there has been no noticeable feeding since. The diameter breast height measurements averaged 8.5 inches. Seven trees died in 1935 and two in 1936. On September 9, 1936, borers were noted working in two living trees; also noted were four trees in a dying condition. It is believed that the soil and moisture conditions, as well as other factors, are particularly favorable for the recovery of these trees; otherwise the mortality would have been much greater.

Neodiprion sp. - The infestations of this insect, reported in 1935 in red pine plantations at Marlboro and Sudbury, Massachusetts,

were controlled in 1936 by lead arsenate sprays. A new outbreak occurred in 1936 in a red pine plantation of about 4 acres at Groton, Massachusetts, causing severe defoliation. The adult sawflies issue in September and October; winter is passed in the egg stage in the green needles; the larvae feed during May and the first half of June; and they are in the cocoon stage ordinarily from mid-June to early September. In rearing experiments it has been found that sometimes there is a considerable "hold-over"; that is, many prepupae remain dormant in their cocoons throughout one whole year. Insect parasites accounted for approximately 25 percent of the cocoons at the Groton infestation, and ground-inhabiting mammals are also important as control agents. Adults have been sent to Washington for specific determination.

Malacosoma disstria Hbn. - The forest tent caterpillar caused more defoliation this past summer than in 1935, particularly in Vermont, where defoliated areas ranged from a few shade trees in a village to several hundred in larger towns, or in sugar orchards and mixed hardwood forests ranging from 1 to 100 acres or more in extent. The most extensive injury in Vermont occurred in Bennington, Rutland, and Windsor Counties, where, in addition to the many acres completely defoliated, thousands of acres ranged from 50 percent to 75 percent.

Samples of 199 egg clusters last spring showed an average of only 4 percent parasitization, and collections of full grown larvae and cocoons from 9 localities in Vermont produced an average of 28 percent parasitization. Disease was rather heavy in some localities,

particularly where overpopulation occurred. Dead and dying sugar maple trees as a result of two or more years of defoliation were noted in three localities.

Egg clusters are now plentiful in many places. In 8 localities in Vermont, sample collections were made at rates varying from 49 to 86 per hour.

Oak Twig Dieback - This study was continued in 1936 to check thoroughly the information obtained in 1935. On may 12, 200 oak twigs and 100 each of chestnut, maple, and birch were tagged. These were examined on June 6, July 8, August 1, and September 9. The results obtained corroborate those for 1935--that is, that late spring frosts may kill the buds and young twigs and cause a definite "dieback." In the main, insect and fungus attack causing dieback, in the area studied, may be considered as negligible.

A final report has been prepared in cooperation with J. R. Hansbrough, of the Division of Forest Pathology.

Pristiphora geniculata Hartig - This European sawfly seems to be present through the Northeastern states wherever its food plant is at all common. Mountain ash in the Green Mountain National Forest and the Bettell Park, Vermont, and in Acadia National Park, Maine, were defoliated during last July.

Plans for Fiscal Year 1938

Living or dead insects with their host plants may be sent to the Forest Insect Laboratory, 56 Hillhouse Avenue, New Haven, Connecticut, for identification and advice on control measures. A note

should be enclosed giving date, locality, food plant, abundance, name and address of collector, and any other information of importance. It may be necessary to rear immature stages through to adults for identification purposes or for data on parasitization.

This rearing work, observations on forest insects of importance, identification of insect pests, and advice on control measures will be conducted as in previous years.

Assignment

J. V. Schaffner, Jr., and H. J. MacAloney, Bureau of Entomology and Plant Quarantine.

PROTECTION

Project

Control of the white pine weevil. (Pi-4)

Scope

To determine practical and effective measures for the control of the white pine weevil, and for minimizing the damage caused by it.

Status

This project was begun at the New York State College of Forestry in 1923, and has been carried on as a major problem at the Northeastern Forest Experiment Station and the New Haven Forest Insects Laboratory since 1923. This project has been completed with the exception of the study of sample plots at New Haven, Conn., and Keene, New Hampshire, to demonstrate the practicability of improving young stands by removing the weeviled leaders.

Results

It has been shown, in the bulletins and reports, that the injury caused by the white pine weevil can be greatly minimized by proper forest practices. Where possible, the several susceptible pines and spruces should be grown in group-wise mixtures with non-susceptible species, preferably hemlock or the better hardwoods which will have value in the final crop. Pure plantations should be planted densely in order to have a satisfactory number of trees of good form. A 4' x 4' or 5' x 5' spacing is advised, even though

expense of planting is considerable. Existing plantations which have reached a height of one log (16 feet), and where the spacing is approximately 6' x 6', can be reclaimed successfully. In younger plantations, just becoming susceptible to weeviling, the removal of the weeviled tips is recommended for two reasons--the ultimate elimination of forks and bad crooks and the reduction of the weevil population.

Progress During 1936

The final pruning and girdling operations in the reclamation plots at Petersham, Massachusetts, were made, and a final report will be prepared.

Plans for Fiscal Year 1938

Time did not permit the examination of the improvement plots at New Haven, Connecticut, and Keene, New Hampshire, in 1936. This will be done in 1937.

Assignment

H. J. MacAloney, Bureau of Entomology and Plant Quarantine, in cooperation with Harvard Forest, Connecticut Agricultural Experiment Station, and Yale School of Forestry.

PROTECTION

Project

Fir bark louse investigation. (Pi-8)

Scope

To determine the extent of infestation and damage throughout the Northeastern States. To study the ecological relations of this insect to balsam fir under various growth conditions, and to develop control measures applicable by forest management. To carry out life history studies where necessary and determine the relationship between the insect and its host.

Status

This project was initiated in June 1934. An extensive survey revealed the presence of the fir bark louse throughout New England, where balsam fir is common. Scouting by the Conservation Department, New York, has shown its presence in the southern part of the Adirondack Mountains. The infestation in most of New England was noticeably less than in 1935.

The spraying experiment at Grantham, New Hampshire, was very successful. It not only demonstrated that the fir bark louse can be controlled by a lime sulphur spray or a miscible oil spray, but also that the fir bark louse itself is the causal agent in the death of balsam fir trees. There was an increase in infestation in some of the trees in the check plot, whereas there was complete control in the sprayed plots, and many of the sprayed trees are more vigorous than before they were sprayed.

Plans for Fiscal Year 1938

The only work planned is of an advisory nature in connection with a control project to be carried out by the Civilian Conservation Corps at the Speculator Camp in the Adirondack Mountains, New York.

Assignment

H. J. MacAloney, Field Studies; S. F. Potts, Insecticides.

In cooperation with the New York Conservation Department.

PROTECTION

Project

European spruce sawfly. (Pi-9)

Scope

To make an extensive survey to determine the extent and severity of infestation of the European spruce sawfly in the United States; to make studies of its life history and habits; and to develop control measures and means of reducing the damage.

Status

This project was begun in 1935 as an extensive survey, and the insect was found to be generally present throughout New England and New York wherever spruce was growing, either in natural stands or plantations.

Results

Laboratory studies conducted during the winter of 1935-1936 indicate that Norway spruce and Colorado blue spruce, as well as the three native species, are subject to attack. Field studies showed that there are at least three generations in Connecticut, while in the rest of New England, except the very northern part of Maine, there should be two. The northern part of Maine is somewhat similar to Quebec and northern New Brunswick and should have one complete generation, and a partial second under favorable weather conditions.

Approximately 800,000 parasites were liberated in several localities in Maine, Massachusetts, New Hampshire, Connecticut, and New York. These were supplied by the Dominion Entomological Branch.

Experimental work at New Haven indicates that lead arsenate will give good control throughout the season if an adhesive is added. Other materials, such as calcium arsenate, derris and lime sulphur, show promise.

The insect did not increase in abundance in 1936 in any locality actually examined by this Division. Heavy defoliation and high cocoon counts were, however, reported from northern Maine in the valley of the St. John and Allegash Rivers. Freezing temperatures, approximately 15° F., in November killed the young larvae in both 1935 and 1936.

Plans for Fiscal Year 1938

The above studies will be continued, and series of sample plots will be established in various portions of the Northeastern United States to study the ecological phases of this problem and to determine the degree of injury.

Publications and Reports

MacAloney, H. J. The European Spruce Sawfly (Diprion polytomum Hartig). Tree Pest Leaflet No. 6. Massachusetts Forest and Park Association (cooperating with various State and Federal Departments). October 1936.

_____ The European Spruce Sawfly. Proceedings 12th National Shade Tree Conference. December 1936.

Assignment

H. J. MacAloney, Life History and Ecology; P. B. Dowden, Parasites; S. F. Potts, Insecticides.

PROTECTION

Project

Larch casebearer (Coleophora laricella Hbn.) investigations in New England and New York. (P1-11)

Scope

To bring about natural control by the introduction of the parasites from its native habitat. To determine the injury being caused by this insect in both plantations and natural stands of larch.

Status

Parasites are being imported from Europe and colonized in various infested stands of larch throughout the northeastern part of the United States.

Sample plots have been established in plantations of European larch and in natural stands of American larch to study the injury, the rise and fall of infestation, and the control by natural factors.

Results for 1936

The infestations in general were much lighter throughout New England in 1936; however, in some localities in Maine and New Hampshire, and in the region of Lake Placid and Saranac, New York, much of the larch foliage was severely browned by this pest. The extreme cold about the third week in May ruined some of the foliage.

Recoveries of two of the introduced parasites, Chrysocharis laricinellae and Bassus pumilus, were made at some of the colonization points in northern New England and New York, thus proving their

establishment. Parasites reared in 1936 from material collected in England by W. F. Sellers of this Bureau were liberated in favorable situations in New England.

Based on collections made in April from trees bordering nine of the sample plots, the winter survival ranged from 11 percent at Sidney, Maine, to 70 percent at Lunenburg, Massachusetts, and Saranac, New York, with an average of 46 percent. Birds removed an average of 14 percent of the larvae from their cases during the winter and early spring, varying considerably in different localities.

Plans for Fiscal Year 1938

Observations will be continued.

Assignment

P. B. Dowden, (Parasites); J. V. Schaffner, Jr., (Field Studies), Bureau of Entomology and Plant Quarantine.

PROTECTION

Project

The Ecology of the Gypsy Moth. (Pi-12)

Scope

The object of this investigation is to define the degree of correlation existing between population intensities and food plant combinations; the degree of correlation existing between minimum winter temperatures and egg survival, and between hatching dates and leaf development in various parts of New England; the degree of correlation existing between growth conditions and tree mortality in the older infested region. This information is essential to clear cut recommendations for control by forest management.

Status

This project is an elaboration of studies carried on for many years. The work falls under three general headings, namely, (1) food plant studies in laboratory, (2) food plant studies in field, and (3) foliage development and hatching of eggs.

Progress During 1936

A series of 20 rearing trays were run from May 17 to June 9 at Freetown, Massachusetts. The purpose was to compare rate of larval growth when confined to foliage of different ages and from trees of different ages. Mortality data were taken, as well as frass collections at regular intervals.

In a one-eighth acre plot at Freetown, an effort was made to compare rates of feeding and mortality of gypsy moth larvae with

fluctuations in various meteorological phenomena, such as temperature, humidity, evaporation, precipitation, et cetera. Similar meteorological data were obtained at the same time in a non-infested hardwood stand on the New Haven Watershed, just outside of New Haven, Connecticut. Data were obtained from the top of the crown, middle of the crown, bottom of the crown, and within 12 inches of the ground.

The Petersham studies were continued and a survey similar to that of 1935 was made. There was a great reduction in extent and degree of defoliation from that of 1933. This was generally true throughout western New England as well. Six sample plots were also located on the Harvard Forest for studying injury and fluctuations in populations.

Forest type surveys were made in the towns of Redding, Winchester, and Guilford, Connecticut. More intensive surveys were made in western Massachusetts and Connecticut in the towns of Washington, Sheffield, West Stockbridge, and Warren; Meriden and Wallingford, respectively. These data are being compiled and maps will be constructed later.

Hatching data from a series of locations in New England were secured as in 1935. Phenological data will be obtained later from these same localities and comparisons between foliage development and hatching dates made.

Plans for Fiscal Year 1938

The Petersham studies will be continued, as will the studies on phenological and hatching conditions in several parts of the infested region. It is further planned, if possible, to conduct an intensive ecological study of the gypsy moth in light infestations.

Publications

Baker, W. L., and Cline, A. C. A Study of the Gypsy Moth in the Town of Petersham, Massachusetts, in 1935. Journal of Forestry 34(8):759-765. August 1936.

Behre, C. Edward, Cline, A. C., and Baker, W. L. Silvicultural Control of the Gypsy Moth. Massachusetts Forest and Park Association Bulletin 137. August 1936.

Assignment

W. L. Baker

PROTECTION

Project

European Pine Shoot Moth (Rhyacionia buoliana Schiff.)

(Pi-13)

Scope

To establish in this country the European parasites of the Shoot Moth and thus aid in natural control. To study the damage caused by the pest and to obtain data on winter mortality and the northern limits of its destructiveness.

Status

The Division of Forest Insects, Bureau of Entomology and Plant Quarantine, has been importing and colonizing parasites of this pest since 1931. In 1936, W. F. Sellers of this Bureau sent several shipments from England. Field observations are being made to note injury, northern range, and choice of food plants. Collections of larvae and pupae for information on parasitization by native species and for recovery of the introduced species, as well as dissections of field collected larvae in the spring for data on winter mortality form important phases of the study. The states concerned have co-operated and assisted in making field collections, in colonizing the parasites and in supplying information on areas infested.

Progress During 1936

The most severe infestations of this pest seem to be confined to plantations in southwestern Connecticut and in the southern half of Westchester County, and on Long Island, New York. Light

infestations occur as far north as eastern Massachusetts, mostly within a few miles of the seacoast.

Two species of the European parasites were recovered again in 1936, some of these from new localities, thus indicating they are now firmly established in this country.

Parasites imported in 1936 were liberated in infested pine plantations in Connecticut, New York, and New Jersey.

At Syosset, Long Island, in a red pine plantation of 10-12 years' growth, which has been heavily infested by the European pine shoot moth for several years, it was noted that several trees had died during 1935. On July 2, 1936, the majority of the trees were dead or dying, and on examination it was disclosed that Pissodes approximatus was causing the death. Thus the trees severely weakened by continued attacks of the shoot moth finally succumbed from attacks by P. approximatus.

Plans for Fiscal Year 1938

Observations will be continued.

Assignment

J. V. Schaffner, Jr., Bureau of Entomology and Plant Quarantine, and P. B. Dowden (Parasites).

PROTECTION

Project

Beech Scale, Cryptococcus fagi (Baer.) Dougl. Investigations. (Pi-14).

Scope

To determine the injury to beech resulting from scale attack; the interrelationship with the fungus, Nectria sp.; the factors affecting the increase of the insect; the control of the insect.

Status

This project is carried on cooperatively by the Division of Forest Insects, Bureau of Entomology and Plant Quarantine, and the Division of Forest Pathology, Bureau of Plant Industry. It is primarily a field project. Permanent sample plots located in Maine and Massachusetts are visited each year and observations made concerning the abundance of the insect, the condition of the trees, and the effect of climatic and other natural control factors. Additional sample plots were established in 1936 at Melrose and Watertown, Massachusetts; Hartford, Connecticut; Westchester County and Long Island, New York. Insecticide investigations were concluded.

The project was started in 1931 by the Bureau of Entomology and Plant Quarantine and became a cooperative project with the Bureau of Plant Industry in 1933. It was undertaken because of the recent discovery of the insect in the United States and because of the tremendous mortality of beech which had occurred in the Canadian Maritime provinces as a result of insect and fungus attack. The information gained thus far concerning the insect in the United States

has been presented in four short publications.

Results in 1936

The beech scale was discovered at Roslyn and Locust Valley, Long Island, New York. The infestation in these towns was very light. An examination of permanent sample plots in Maine indicated a definite increase over 1935, and in many areas heavily infested trees occur at the present time. The heavy infestation persists on a number of ornamental trees in the City of Hartford, Connecticut. There was a definite increase in Westchester County, New York, although the infestation is light in the metropolitan parks of this county. One tree in Beverly, Massachusetts, is apparently dying from scale attack; although a species of Nectria is present on the bark of this tree, it does not seem to have been instrumental in causing its death from the evidence at hand.

Plans for Fiscal Year 1938

Analysis of data from permanent sample plots. Continuation of observations in sample plots. Detailed studies on injury caused by the scale. Scouting new areas if time and funds permit.

Publications

Brown, R. C. The Beech Scale, Cryptococcus fagi (Baer.) Dougl. Tree Pest Leaflet No. 4. Massachusetts Forest and Park Association. 1936.

Assignment

R. C. Brown, Bureau of Entomology and Plant Quarantine.

SUMMARY OF PERMANENT SAMPLE PLOTS

The number of permanent sample plots now being maintained by the Forest Service in the Northeast is 1,019, involving a total area of 475.19 acres. In addition to these forest management plots, numerous other plots are being maintained in this region by the other cooperating bureaus. The Forest Service plots are distributed among the states as follows:

State	Number of Plots	Total Area
Maine	74	21.49
New Hampshire	328	190.58
Vermont	64	18.84
Massachusetts	50	37.99
Connecticut	61	16.03
New York	442	190.26
Total	1,019	475.19

PERMANENT SAMPLE PLOTS
Maintained by the
Northeastern Forest Experiment Station

Serial plot number	Locality	Object	Project	No. of plots	Acreage	Date Established	Remeasurement date
		Maine					
1-12	Westbrook	Development of planted northern white pine	P-1	12	11.25	1914	1940
28-43	Rockwood	Growth and reproduction of spruce and hardwoods after logging	M-1	16	2.00	1925	1941
44-50	Lily Bay	Growth and reproduction of spruce and hardwoods after logging	M-1	7	.875	1925	1937
52	Brighton	Importance of seed source on development of Scotch pine	P-1	1	1.0*	1932	1940
53	Waterboro	Cost of selective logging of old field white pine and development subsequent to logging	Prod. cost	1	2.0	1934	1939
54	Waterboro	Cost of clear cutting old field white pine and development subsequent to logging	Prod. cost	1	.25	1934	1939
55-59	Bingham	Growth of northern hardwoods	ME-3	5	.7454	1934	1939
60-62	Brighton	Growth of northern hardwoods	ME-3	3	.5378	1934	1939
63-67	Kingfield	Growth of northern hardwoods	ME-3	5	.7059	1934	1939
68-76	Liberty	Growth of northern hardwoods	ME-3	9	.4966	1934	1939
78-89	Dennysville	Study growth and yield of spruce and fir on cut-over lands in spruce-flat type	M-1	12	1.50	1925	1939
90-91	Guerette	Study growth and yield of spruce and fir on cut-over lands in spruce-flat type	M-1	2	.25	1925	1939

*approximate

Serial plot number	Object	Project	No. of plots	Acreage	Date Established	Recommendation date
	New Hampshire					
1-6	Corbin Park: Growth and yield of even-aged spruce	NH-2	6	3.00	1904	1940
7-9	Corbin Park: Development of spruce under hardwoods	N-1	3	1.80	1906	1940
10-11	Corbin Park: Thinning in northern white pine	N-3	2	1.00	1906	1940
20-21	Corbin Park: Thinning in old field red spruce	N-1	2	.40	1906	1940
22-25	Waterville: Reproduction after logging in red spruce and northern hardwoods	N-1	4	2.00	1906	1940
26	Waterville: Reproduction after logging in red spruce and northern hardwoods	N-1	1	.05	1906	1937
28	Waterville: Reproduction after logging on spruce slope	N-1	1	.044	1906	1937
30-32	Peterboro: Development of old field northern white pine	N-3	3	1.10	1906	1940
33, 35-38	Peterboro: Development of planted northern white pine	N-3	5	1.35	1906	1940
39-40	Peterboro: Thinning in northern white pine	N-3	2	.25	1906	1940
41-42	Peterboro: Thinning in mixed pine and hardwoods	N-3	2	.45	1906	1940
47-48	Peterboro: Releasing pine from hardwoods	N-3	2	.75	1906	1940
51-55,	Manchester: Growth of planted and natural northern white pine	N-3	6	1.167	1906	1940
59-62	Cherry Mountain: Methods of cutting in red spruce and northern hardwoods	N-1	4	2.00	1934	1959

Serial plot number	Locality	Object	Project	No. of plots	Acreage	Date Established	Remeasurement date
		New Hampshire					
63-64	Cherry Mountain	Slash disposal methods in red spruce and northern hardwoods	M-1	2	8.40	1926	1940
66-67	Cherry Mountain	Slash disposal methods in red spruce and northern hardwoods	M-1	2	10.00	1926	1937
68-71	Cherry Mountain	Weeding in red spruce and northern hardwoods	M-1	4	1.00	1927	1937
72-74	Waterville	Weeding in red spruce and northern hardwoods	M-1	3	.75	1928	1938
75-77	Waterville	Slash disposal methods in red spruce and northern hardwoods	M-1	3	6.00	1928	1938
78-80	Johnson Brook	Slash disposal methods in red spruce and northern hardwoods	M-1	3	6.00	1928	1939
81-83	Gale River Bethlehem	Growth and development of even-aged spruce and fir	MB-2	3	.552	1928	1938
84-85	Franconia	Growth and development of even-aged spruce and fir	MB-2	2	.417	1928	1938
86-87	Gale River Forest	Growth and development of black spruce	MB-2	2	.20	1928	1938
88-89	Gale River	Growth and development of even-aged red spruce and fir	MB-2	2	.36	1928	1938
90	Gale River Forest	Growth and development of red spruce and northern hardwoods	MB-2	1	.308	1928	1938
91	Gale River Forest	Growth and development of black spruce	MB-2	1	.15	1928	1938

Serial plot number		Object	Project	No. of plots	Acreage	Date Established	Recommination date
		New Hampshire					
92-93	Waterville	Girdling in red spruce and northern hardwoods	M-1	2	1.00	1928	1938
94-96	Waterville	Girdling in red spruce and northern hardwoods	M-1	3	2.50	1929	1937
99, 100 102, 106 and 107	Cherry Mountain	Management of red spruce-northern hardwoods for spruce production	M-1	5	25.00	1930	1940
101, 103, 104, 105, and 108	Cherry Mountain	Management of red spruce-northern hardwoods for spruce production	M-1	5	25.00	1930	1940
109-112	Cherry Mountain	Management of pure spruce stands for spruce production	M-1	4	2.00	1930	1938
129-145	Warner	Development of planted northern white pine, Norway pine, and white ash	P-1	15	13.125	1914	1940
144-152	New Durham	Development of planted northern white pine	P-1	9	6.75	1914	1940
153-156	Corbin Park	Thinning of northern hardwoods and subsequent deterioration of yellow birch	MS-3	4	2.00	1936	1940
157*	Peterboro	Development of old field white pine	M-3	1	.10	1930	1940
158-167	Errol	Growth and reproduction of spruce and hardwoods after logging	M-1	10	1.25	1928	1937
168-169	Bartlett	Effect of moderate thinning on birch and other species making up residual stand	MS-3	2	1.25	1932	1937

*Check Plot on No. 30

Serial plot number	Locality	Object	Project	No. of plots	Acreage	Date Established	Recommination date
		New Hampshire					
170-172	Gale River	Possibility of increasing spruce production through removal of balsam fir and hardwoods	M-1	3	.75	1932	1937
173	Gale River	Effect of removing balsam fir only from mixed stand of spruce, fir, paper birch, and aspen	M-1	1	.25	1932	1937
174-177	Gale River	Effect of degrees of thinning in pure pulpwood stand	M-1	4	1.00	1932	1937
178-181	Pittsburg	Growth and reproduction of spruce and hardwoods after logging	M-1	4	.90	1925	1937
182	Gale River	Growth, yield, and changes in density of even-aged second-growth stands of northern hardwoods	ME-3	1	.2712	1932	1937
183-184	Bartlett	Growth, yield, and changes in density of even-aged second-growth stands of northern hardwoods	ME-3	2	.50	1932	1937
185	Peterboro	Importance of seed source on development of Scotch pine	F-1	1	1.00*	1932	1937
186	Wildwood	Importance of seed source on development of Scotch pine	F-1	1	1.00*	1932	1937
187-191	Bartlett	Development of conifers planted in open hardwood stand	ME-3	5	1.25	1934	1937
192-204	Bartlett	Effect of weeding on northern hardwoods	ME-3	13	1.90	1933	1938
205	Bartlett	Effect of clear cutting on reproduction	ME-3	1	2.50	1933	1938

*approximate

Serial plot number	Locality	Object	Project	No. of plots	Acreage	Date Established	Recommendation date
		New Hampshire					
206	Bartlett	Effect of partial cutting on residual stand and reproduction	NH-S	1	2.50	1933	1938
207-214	Bartlett	Effect of weeding on cutover land	NH-S	8	.80	1934	1938
215-216	Gale River	Release of spruce plantation from overstory of aspen	N-1	2	.50	1935	1937
217-223	Gale River	Release of spruce plantation from overstory of aspen	N-1	7	1.75	1935	1938
224	Bartlett	Effect of clear cutting on reproduction	NH-S	1	2.5	1934	1939
225	Bartlett	Effect of partial cutting on residual stand and reproduction	NH-S	1	2.5	1934	1939
226-227	Marlboro	Cost of selective logging of old field white pine and development subsequent to logging	Prod. Cost	2	.66	1934	1939
228-231	Gilmanton	Cost of clear cutting old field white pine and development subsequent to logging	Prod. cost	4	1.50	1934	1939
232	Holderness	Cost of selective logging of old field white pine and development subsequent to logging	Prod. cost	1	1.46	1934	1939
233	Bartlett	Development of Norway pine plantation	NH-S	1	.11	1934	1937
234	Ponemah	Determine advantage of one type to region	P-1	1	2.00*	1934	1937
235	Gale River	Release of spruce plantation from overstory of aspen	N-1	1	.25	1935	1937

*approximate

Serial plot number	Locality	Object	Project	No. of plots	Acreage	Date Established	Recommination date
		New Hampshire					
236-241	Gale River	Effect of girdling on subsequent sprouting and root suckering of girdled trees	M-1	6	.60	1935	1937
242-243	Gale River	Effect of girdling hardwoods on growth rate of released conifers	M-1	2	1.00	1935	1937
247	Bartlett	Effect of clear cutting on an all-aged northern hardwood stand	ME-3	1	2.50	1935	1940
248	Bartlett	Effect of improvement cutting on an all-aged northern hardwood stand	ME-3	1	2.50	1935	1940
249-251	Danbury	Study the development of an all-aged northern hardwood stand following a commercial selection system of cutting	Prod. cost	3	1.55	1935	1940
252-298	Gale River	Determine species best suited to burned over spruce lands	M-1	47	4.625	1934	1937
299-346	Gale River	Determine effect of drainage on growth rate of spruce	M-1	48	.192	1934	1939
347	Columbia	To determine the effect of light cutting on future development of second growth spruce and fir	ME-2	1	.20	1936	1941
348	Columbia	To determine the effect of heavy cutting on future development of second growth spruce and fir	ME-2	1	.20	1936	1941
349-350	Bartlett	Effect of partial cutting on residual stand and reproduction	ME-3	2	5.00	1936	1941
351-352	Bartlett	Development of residual stand after thinning in an even-aged hardwood stand	ME-3	2	10.00	1936	1941
353-366	Bartlett	Development of reproduction on relatively small clear cut areas	ME-3	14	4.75	1936	1941

Serial plot number	Locality	Object	Project	No. of plots	Acreage	Date established	Recommendation date
		Vermont					
1-5	Pomfret	Growth-yield of second-growth northern hardwoods after thinning	ME-3	5	.50	1904	1945
6-11	Sharon	Increment in northern hardwoods and hemlock	ME-3	6	3.00	1904	1945
12-18	Sherburne	Methods of cutting in spruce and northern hardwoods	M-1	7	1.15	1906	1937
19-22	West Rochester	Methods of cutting in spruce and northern hardwoods	M-1	4	1.10	1906	1940
23-24	West Rochester	Thinning in even-aged northern hardwoods	ME-3	2	.52	1906	1940
25-27	Plainfield	Slash disposal in old field spruce	M-1	3	.75	1927	1937
28-29	Battell Forest	Methods of cutting in red spruce and northern hardwoods	M-1	2	1.00	1927	1937
30-34	Battell Forest	Growth and development of old field spruce	ME-2	5	1.10	1927	1937
35-37	Battell Forest	Weeding in red spruce and northern hardwoods	M-1	3	1.80	1927	1937
38	Bolton	Effect of girdling hardwoods on growth rate of released spruce of merchantable size	M-1	1	1.00	1931	1937
39-42	Plainfield Springs	Growth, yield, and changes in density of even-aged second-growth northern hardwoods	ME-3	4	.43959	1932	1937
43	Barre	Growth, yield, and changes in density of even-aged second-growth northern hardwoods	ME-3	1	.1600	1932	1937

Serial plot number	Locality	Object	Project	No. of plots	Acreage	Date Established	Recommendation date
		Vermont					
44-45	Williamstown Gulf	Growth, yield, and changes in density of even-aged second-growth northern hardwoods	NE-S	2	.6447	1932	1937
46-50	Groton State	Growth, yield, and changes in density of even-aged second-growth northern hardwoods	NE-S	5	1.0992	1932	1937
51	Middlesex	Growth, yield, and changes in density of even-aged second-growth northern hardwoods	NE-S	1	.2162	1932	1937
52	South Duxbury	Growth, yield, and changes in density of even-aged second-growth northern hardwoods	NE-S	1	.1979	1932	1937
53-54	Waterbury	Growth, yield, and changes in density of even-aged second-growth northern hardwoods	NE-S	2	.207	1932	1937
55-56	Stimson Mountain	Growth, yield, and changes in density of even-aged second-growth northern hardwoods	NE-S	2	.50	1932	1937
57	Peru	Importance of seed source on development of Scotch pine	P-1	1	1.0*	1932	1937
61-66	Danby	Yield of northern hardwoods	NE-S	6	1.6406	1934	1939
67	Rendville	Study the development of an all-aged northern hardwood stand following a commercial selection system of cutting	Prod. cost	1	1.50	1935	1940

*approximate

Serial plot number	Locality	Object	Project	No. of plots	Acreage	Date Established	Reexamination date
		Massachusetts					
1-2	Mt. Toby Forest	Growth of Scotch pine plantation	F-1	2	1.00	1924	1937
3	Mt. Toby Forest	Growth of Norway pine plantation	F-1	1	.50	1924	1937
4	Mt. Toby Forest	Growth of northern white pine plantation	F-1	1	.50	1924	1937
5-7	Mt. Toby Forest	Planted white pine under hemlock and hardwoods	M-3	3	.75	1924	1940
8-9	Mt. Toby Forest	Planted white pine following chestnut	M-3	2	.50	1924	1940
10	Mt. Toby Forest	Natural reproduction following chestnut	M-3	1	.10	1927	1940
11-22	Duxbury	Growth, development and reproduction of white pine	M-3	12	2.66	1915	1940
23-40	North Andover	Development of central hardwoods	M-2	18	19.67	1915	1940
42-46	Dover	Development of central hardwoods with understory of white pine	M-2	5	2.97	1915	1940
47	Cape Cod Shawme State Forest	Importance of seed source on the development of Scotch pine	F-1	1	1.00*	1932	1940
48	Monterey Swann State Forest	Importance of seed source on the development of Scotch pine	F-1	1	1.00*	1932	1940
49	Templeton State Forest	Importance of seed source on the development of Scotch pine	F-1	1	1.00*	1932	1940
50	Townsend	Cost of selective logging and clear cutting old field white pine and development subsequent to cutting	Prod. cost	1	4.01	1934	1939
51	Duxbury	Growth, development reproduction of white pine	M-3	1	2.13	1915	1940

*approximate

Serial plot number	Locality	Object	Project	No. of plots	Acreage	Date Established	Remeasurination date
		Connecticut					
1-2	Union	Reproduction in white pine after clear cutting	M-3	2	1.00	1906	1940
3-4	Farmington	Thinning in central hardwoods	M-2	2	.50	1906	1940
5-10	Farmington	Thinning in central hardwood coppice	M-2	6	1.66	1906	1940
11-16	Windham	Thinning in central hardwood coppice	M-2	6	.80	1906	1940
17-19	Windham	Natural reproduction following chestnut	M-3	3	1.50	1906	1940
20-24	Windham	Natural reproduction and planted pine following chestnut	M-3	5	1.25	1906	1940
25-29	Simsbury	Effect of burning in central hardwoods	M-2	5	.50	1924	1938
30	Burlington	Importance of seed source on development of white pine	P-1	1	1.00*	1932	1940
31-42	North Branford	Effect of depth of planting on root development and future growth in Norway pine	P-1	12	3.00	1933	1938
45-47	North Branford	Effect of depth of planting on root development and future growth in white pine	P-1	3	1.25	1933	1938
48-54	Guilford	Effect of depth of planting on root development and future growth in white pine	P-1	7	1.75	1933	1938
55-57	North Branford	Effect of depth of planting on root development and future growth in white spruce	P-1	3	.75	1933	1938
58	Guilford	Effect of depth of planting on root development and future growth in white spruce	P-1	1	.25	1933	1938
59-61	North Branford	Effect of depth of planting on root development and future growth in white spruce	P-1	3	.75	1933	1938

*approximate

Serial plot number	Locality	Object	Project	No. of plots	Acreage	Date Established	Reexamination date
		New York					
1-5	Indian Lake	Growth and reproduction of red spruce and northern hardwoods after logging	M-1	5	.375	1924	1940
4-17	Deerland	Growth and reproduction of red spruce and northern hardwoods after logging	M-1	14	1.75	1924	1940
18-27	Deerland	Growth and reproduction of red spruce and northern hardwoods after logging	M-1	10	1.25	1925	1940
28-35	Little Tupper Lake	Growth and reproduction of red spruce and northern hardwoods after logging	M-1	8	1.00	1925	1940
36-39	Deerland	Growth and reproduction of red spruce and northern hardwoods after logging	M-1	4	.50	1925	1940
40-57	Long Lake	Growth and reproduction of red spruce and northern hardwoods after logging	M-1	18	2.25	1925	1940
58-62	Newcomb	Determination of best methods of cutting in red spruce and northern hardwoods	M-1	5	140.00	1930	1940
63-66	Elk Lake	Growth and reproduction of spruce and hardwoods after cutting	M-1	4	.50	1924	1940
67-68	Newcomb	Effect of girdling hardwoods on growth rate of released spruce of merchantable size	M-1	2	10.00	1932	1937
69-104	Chemango	Effect of depth of planting on root development and growth of Norway pine, white pine, white spruce, and Norway spruce	P-1	36	**	1933	1937

**The total area of all plots established at the Chemango Experimental Forest to date is approximately 28 acres.

Serial plot number	Object		Project	No. of plots	Acreage	Date Established	Reexamination date
		New York					
166-168	Chemango	Methods of establishing mixtures of white pine and desirable hardwoods	P-1	2	**	1933	1937
167	Chemango	Growth of Pinus peuce	P-1	1	**	1934	1937
169-179	Chemango	Methods of establishing mixtures of white pine and desirable hardwoods	P-1	24	**	1936	1937
180-227	Chemango	Effect of methods of planting	P-1	48	**	1934	1937
228-238	Chemango	Comparison of pure plantations of white pine with mixed stands	P-1	11	**	1934	1937
239-245	Pine Hill	Growth of northern hardwoods	MB-S	7	1.4052	1934	1939
246-247	Fledsch-mann's	Growth of northern hardwoods	MB-S	2	.389	1934	1939
248-267	Chemango	Study value of different planting methods	P-1	20	**	1933	1937
268A-272	Chemango	Determination of species and age best suited to damp land planting	P-1	6	**	1936	1937
273A-B	Chemango	Establishing mixtures of hardwoods and white pine	P-1	2	**	1936	1937
274-307	Chemango	Study value of different planting methods	P-1	34	**	1933	1937
308-309	Blue Mtn. Lake	Growth and reproduction of red spruce and northern hardwoods after logging	B-1	2	.25	1924	1940
310-325	Chemango	Study effect of interplanting hardwoods between white pine	P-1	20	**	1936	1937

Serial plot number		Object	Project	No. of plots	Acreage	Date Established	Recommination date
		New York					
326	Chenango	Study species best adapted to damp land planting	P-1	1	**	1936	1937
327A-328B	Chenango	Establishing mixtures of white pine and hardwoods	P-1	20	**	1936	1937
330-342	Chenango	Growth of root pruned seedlings	P-1	4	**	1936	1937
343	Ohio	Study the development of an all-aged northern hardwood stand following a commercial selection system of cutting	Prod. cost	1	1.80	1935	1940
349-501 (not inclusive. Remainder to be planted in 1937.)	Chenango	Group planting to develop mixed plantations	P-1	71	**	1935-1936	1937
502-505	Newcomb	To determine the effect of selective girdling on increased growth of conifer pulpwood trees	M-1	2	1.00	1932	1937

PLOTS ABANDONED OR RECOMMENDED TO BE ABANDONED IN 1936

Plot No.	Locality	Object	Project	Acreage	Reason for abandonment
51	Alfred, Maine	Importance of seed source on development of Scotch pine	Fp	1.00 approx.	Heavy mortality has depleted growing stock. Only 6 of original 100 staked trees remain on plot.
77	Princeton, Maine	To determine advantage of one type to region	Fp	1.00 approx.	Heavy mortality caused by extreme denseness of ground cover.
58-60	Danby, Vermont	Yield of northern hardwoods	ME-3	0.5778	Cut over by owner

PF-3 STUDY AREAS - EXAMINED ANNUALLY

Region	Location	Acreage	No. of trees	Established
White pine	Kingston, Mass.	0.50	199	1936
Spruce and northern hardwoods	Tahawus, N. Y.	-	57	1933
"	Bartlett, N. H.	-	113	1935
Oak	Lackawack, N. Y.	0.57	135	1933
"	Ramapo, N. Y.	0.62	116	1933
"	New Haven, Conn.	2.00	761	1935
"	Cold Spring, N. Y.	0.25	84	1936
"	Killingly, Conn.	0.10	73	1936

NORTHEASTERN FOREST EXPERIMENT STATION

MANUSCRIPTS TO BE SUBMITTED FOR PUBLICATION IN FISCAL YEAR 1938

Benson, A. O., and Jensen, V. S. The production of lumber from northern white pine in New England - Methods, costs, and values. Estimated length 72 typed pages, 24 tables, 8 figures. For United States Department of Agriculture Technical Bulletin.

Jensen, V. S., and Kraemer, J. H. Costs of pulpwood production in second growth spruce and fir stands of New Hampshire. Estimated length 36 typed pages, 20 tables, 6 figures, illustrated. For United States Department of Agriculture Circular.

Shepard, H. B. Forest fire insurance in the Northeast. Estimated length 200 typed pages, 20 figures, 20 tables. For United States Department of Agriculture Technical Bulletin.

Stickel, P. W. Forest fire danger in the Northeast. Estimated length 100 typed pages, 10 figures, 10 tables. For United States Department of Agriculture Circular.

Westveld, M. Growth of spruce and fir on cut-over lands in the Northeast. Estimated length 65 typed pages, 10 figures, 10 tables. For Journal of Agricultural Research.

The Gale River Experimental Forest. Descriptive Folder similar to National Forest folders, with map and illustrations.

The Bartlett Experimental Forest. Descriptive Folder similar to National Forest folders, with map and illustrations.

NORTHEASTERN FOREST EXPERIMENT STATION

MANUSCRIPTS TO BE SUBMITTED FOR PUBLICATION IN FISCAL YEAR 1939

Jacot, A. P. Animals causing reduction of spruce litter. Estimated 10 pages, illustrated. For Journal of Agricultural Research.

_____ Fauna of the forest litter of spruce forests. Estimated 30 pages, 2 tables, illustrated. For United States Department of Agriculture Technical Bulletin.

Reineke, L. H. Growth rates in the spruce and northern hardwood forests of the Northeast. Estimated 24 pages, 10 tables, and 6 charts. For United States Department of Agriculture Circular.

Schreiner, E. J. Research methods in forest genetics. Estimated 36 pages, illustrated. For United States Department of Agriculture Circular.

Stickel, P. W. Fire damage standards for southern New England and New York. Estimated 24 pages, 5 tables, illustrated. For United States Department of Agriculture Circular.

Westveld, M. Seedbed conditions in relation to reproduction of spruce and fir in the Northeast. Estimated 12 pages, 3 tables. For Journal of Agricultural Research.

_____, and Spaulding, P. Decomposition of logging slash and silvicultural aspects of slash disposal in the spruce types of the Northeast. Estimated 16 pages, 5 tables, illustrated. For Journal of Agricultural Research.

NORTHEASTERN FOREST EXPERIMENT STATION
IMPROVEMENT CONSTRUCTION PROGRAM

Location and Description	Estimate of Amount Required	Fiscal Year for Construction	Possible Source of Funds
Massabesic Experimental Forest			
Alfred, Maine			
2 Staff Dwellings-5 rooms	$ 7,200		
1 Four-car Garage	1,800	1938	CCC
1 Two-car Garage	700		
1 Workshop and Tool Shed	1,500	1939	CCC
Power Line, 1½ miles	1,000	1937-38	ERA
Truck Trails, 8 miles	24,000	1938-40	CCC
Fire Break, 4 miles	2,000	1938-39	CCC
4 Bridges	2,400	1939	CCC
20 Water Holes	1,200	1938	CCC
Bartlett Experimental Forest			
Bartlett, New Hampshire			
1 Res. Supt. Dwelling-Garage	6,000		
2 Woodsheds	600	1938	CCC
Gale River Experimental Forest			
Bethlehem, New Hampshire			
1 Res. Supt. Dwelling-Garage	6,000	1939	?
1 Staff Dwelling	3,000		
Hopkins Memorial Experimental Forest			
Williamstown, Massachusetts			
Greenhouse	3,000	1939	CCC (?)
Bridge	800	1938	CCC (?)
Cold Storage Cellar	1,500	1939	CCC (?)
5 Dams and Weirs	2,000	1937-38	ERA
Truck Trails, 6 miles	27,000	1938-39	CCC (?)
Fire Break, 1.6 miles	1,000	1938	CCC (?)
Chenango Experimental Forest			
Norwich, New York			
Office Building	5,000	1939	?
Workshop and Tool Shed	1,500	1938	CCC (?)
Truck Trails, 2 miles	8,000	1938-39	CCC
Power Line, 2 miles	1,500	1939	?
2 Dams	2,500	1938-39	CCC
Finch Pruyn Experimental Forest			
Newcomb, New York			
Truck Trail, 1.5 miles	7,500	1938	CCC
Bridge	800	1938	CCC

NORTHEASTERN FOREST EXPERIMENT STATION
ANNUAL MAINTENANCE REQUIREMENTS

	Number of Miles	Amount Required
Roads, Forest highways	14	$1,400
Telephone Lines	5½	50
Dwellings	8	500
Garages	7	100
Offices	3	200
Other Structures	13	130
Water Development	4	100
Fire Breaks and Water Holes	11	220
		$2,700